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SOME FACTS ABOUT THE SILVER INDUSTRY.

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THE production of silver in the United States prior to 1845, aggregating perhaps a quarter of a million dollars, was derived mainly from the parting of the $21,500,000 of gold produced in the South. From 1845 to 1858 the output was about $50,000 worth annually, chiefly from the same sources. Silver-mining on an important scale in this country dates from the discovery of the Comstock lode, or the Washoe district, in Nevada, where gold placer-mining had been carried on in a small way, but where the existence of silver ore in quantity was not realized until 1858-59. Some native silver had been obtained from the Lake Superior copper region, but there was no real silver-mining.

When silver was discovered in Nevada, the gold resources of California and Oregon had already attracted a considerable population, whose main dependence was upon the mines. The stream of newcomers, pouring in over different emigrant routes, had in its course led to many discoveries of gold east of the Sierras; while hunters, trappers, and explorers had also found gold. The Pike's Peak rush to Colorado was in full force, too. Everybody was looking for gold and nobody thinking of silver. This extension of gold-seeking had evolved a set of hardy, adventurous prospectors and miners, preëminently fitted to seize upon a new and promising source of wealth. When the importance of the Washoe discovery became recognized, therefore, a rush of prospectors spread over Nevada in search of similar deposits, and later, in 1862-63, overflowed into Idaho and Montana, though always looking first for gold. The combined attractions of the two precious metals brought a wonderfully rapid occupation of wide areas.

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The next great event was the opening of the Leadville district, in Colorado, in 1878. By this time silver-mining had become a regular and important vocation in the West. Besides the Comstock there were many other active districts in Nevada, and also camps in Utah, Idaho, Montana, Colorado, New Mexico, and Arizona. The mining population had largely increased, as had also their knowledge of silver-mining, and an army of prospectors and miners stood ready to scour the country and take up new fields. Soon silver-mining began to outstrip, and finally it almost superseded, gold-mining in the vast area between the Sierras and the one-hundredth meridian.

Towns and cities have sprung up in this section as if by magic, some of them outrivaling older and larger communities in their adoption of advanced means of civilization; railways have been pushed until scarcely an important mining district lacks direct communication with its sources of supply and the distant metallurgical works and markets; manufactures have been inaugurated, agriculture has been stimulated. All this advance in so short a time is attributable to the influence of mining. But this region is not yet wholly self-supporting. It has to draw upon outside sources for a part of its supplies of food, machinery, and mining material. Its exports of produce are not large, cattle, sheep, and wool forming the principal shipments. Otherwise the great reliance is upon bullion exports,—gold, silver, lead, and copper. What would have been the present condition of the far West, but for the stimulus which silver-mining has given to its general development, may be imagined. Its agricultural resources are limited; away from the narrow rain-belts irrigation is necessary to raise a crop, and competition with the prairie States would be too severe if there were no local markets. Up to the present, without mining, the leading industries would have been grazing and wool growing, which imply a sparse and unprogressive population. There would have been no great cities, few railways, no foundries, no smelting-works, and but little demand for skilled labor.

When silver-mining was begun here, we were ignorant of the geological conditions and mineralogical associations of the deposits, their mode of occurrence, and the likeliest places to prospect. In silver metallurgy we were especially deficient. There were no local precedents, technical schools, or trained engineers. Freiburg and Clausthal, the Ecole des Mines, and the Royal School furnished the first mining and metallurgical engineers. Subse-

quently we had our own engineering schools, which are now fully abreast of those in Europe. Experience came to the help of the miners, who by dint of many experiments and costly failures gradually evolved the present system of American mining and metallurgical practice, which now leads the world and is the standard everywhere. We no longer import engineers; we export them.

In metallurgy the advance has been wonderful. Once it cost $100 a ton to either mill or smelt silver ore, and that very wastefully. The Washoe pan-amalgamation process for treating silver ores raw was an offspring of the old patio process combined with the arastra. It was gradually improved until the cost was reduced to $10 and $15 a ton, with a saving of 60 to 80 per cent. of the assay contents of the freest ores. Later it has been brought down as low as $4 a ton. The dry-crushing, chloridizing-roasting, and pan-amalgamation process was introduced for working more rebellious ores, especially those of high grade. Various systems of lixiviation have also been introduced. But it is in lead-smelting for the precious metals that the greatest advance has been made, and by this method the great bulk of the silver ores are now treated. Silver-milling is steadily giving way before smelting. Under the most advantageous conditions this process costs about $4 to $4.50 a ton, and saves 95 per cent. and over of the silver, gold, and lead. As an accessory, there is now the pyritic or iron-matte system of smelting, besides the older copper-matte system, both of which cheaply give a furnace product in shape for shipment and final reduction.

The metallurgy of silver has not reached a finality, but the margin for further improvement has been very greatly reduced. It has been found expedient to separate the mining and treatment of silver ores, the latter operation being conducted on a large scale at great metallurgical centers with the advantages of varied ore supply, transportation, cheap fuel and flux, and nearness to markets. Under this system mines sell their ore outright to the smelters, directly or through ore-brokers and sampling-works. Thus they are saved the expense of building and operating reduction-works, and the better results more than offset freight charges, commissions and smelters' profits.

Silver-mining cannot be discussed without some reference to gold mining. Of the important mines there are more which produce both metals in noteworthy proportions than there are mines distinctively of either gold or silver. The effect of a suspen-

sion of silver-mining would be two-fold: (1) the cessation of work in the purely silver mines would turn (as it already is doing) men and capital into gold-mining, and thus *increase* the gold product; while (2) the closing of the mines producing both metals would *reduce* the gold output. The net result probably would be a gain in gold production, at least for a while.

Silver has also a close connection with lead and copper. The silver ore minerals occur in nature very frequently associated with those of the two "base" metals, besides which the latter are indispensable adjuncts in the smelting processes for the extraction of silver. While the lead ores (mainly galena) farther east run very low in silver contents, those west of the one-hundredth meridian nearly always carry appreciable amounts of silver. In fact few lead mines in the far West could be worked at a profit for lead alone under existing conditions, transportation to market being the great drawback. But with the included silver these western mines are now producing the great bulk of the domestic lead supply. The copper-mines of Montana (Butte), Colorado, and other districts yield much silver also. The copper-matte smelting process saves the silver, which may be subsequently extracted by electrolytic and other wet separating processes, together with any gold present.

It is impossible to state the number of men engaged in silver-mining, the value of plant and improvements, the cash capital involved, and many similar points. The eleventh census (covering the year 1889) does not help us much here, though an attempt was made to ascertain these facts. The census reported the number of men employed in gold- and silver-mining in the whole country at 57,307, including an office force of 873. Only 9585 "miners" were reported for these industries in Colorado, with other workers in connection with mining bringing the total up to 13,196. Now, the reports of the State mine inspectors show that there were then in Colorado fully 20,000 wage-working mine-employés, to whom should be added nearly as many men working their own mines, leasing, tributing, and prospecting. If the teamsters, mechanics, surface laborers, mill-men, and smelter employés are added, there cannot have been fewer than 50,000 men engaged in gold- and silver-mining and -reduction in the one State, of whom about two thirds should be set down to the silver-mining industry as distinguished from the gold interests. On this basis it may be assumed that there were 150,000 or 200,000 men engaged directly and indirectly in silver-mining in the whole country, with a population of say a million

dependent upon that industry. The number is much smaller, since the recent closing of so many mines.

With respect to earnings, precious-metal mining undoubtedly makes a better showing than almost any other important industry. Until very recently the standard rate underground in silver-mines has been $3 per shift of eight to ten hours, with 50 cents added for special skill, as in operating power drills, timbering, etc. In some more distant camps $3.50 a day has been the standard, while on the Comstock and in a few other instances $4 a day underground has been maintained by the unions. Lately, owing to the reduced price of silver, the standard of rates has been cut, and in some cases a sliding scale, adjusted according to silver quotations, has been adopted. The cost of living in silver-mining camps is so much lower than formerly that, without regard to the exigencies of mine management, there is a natural difference of from 50 cents to $1 a day in wages.

A large proportion of the more important silver-mines are not owned in the States where they are located. There is a much larger amount of home capital in silver-mines in Colorado than anywhere else; yet even in that State probably the majority of the big mines are owned in the East and in England. As a rule, the older and more settled a mining region is, the more home capital proportionately is interested in its mines. The largest silver-mining investments in this country are held in New York, San Francisco, Denver, Boston, and St. Louis, in the order named. London long has been a leading market for American silver properties. Paris has not invested so widely, but its few ventures have been on a large scale individually.

It may be of interest to compare the production of silver in the United States with some other important products. Mr. R. P. Rothwell, in his statistics for 1882, estimates the silver output for that year at 64,900,000 troy ounces, worth at full coinage value $83,909,210. The director of the Mint estimates 58,000,000 ounces, valued at coinage rate at $74,989,900. As the Mint statistics have been followed mainly in this paper, we may adopt the more conservative estimate. As bullion in the open market, at the average price of last year, 58,000,000 ounces would be worth $50,750,000, which sum will be the basis of our comparison. The American silver of 1892 was worth, therefore, somewhat more than one-third as much as the pig-iron, one-third more than the copper, about half as much again as the gold, and not

quite three times as much as the lead. It was less than one-sixth the value of all the metals, embracing, in addition to the above, zinc, antimony, nickel, aluminum, etc. Again, the commercial value of the silver was about two-thirds that of the anthracite, two-fifths that of the bituminous coal, and more than one-quarter of the total coal value. It was worth one ninth more than all the building stone, and two-thirds more than the petroleum. It will be noticed that, while silver is of predominating interest over a large area of the country, it is surpassed in importance by some and rivaled by others of the more prosaic products when the whole of the United States is taken into account. The total silver production of the country from 1792 to the end of 1892 amounted to 887,082,527 troy ounces, worth $1,146,869,000 at the coinage value of $1.2929 per ounce,—the only figure available in this computation. During the same hundred years the output of gold in this country reached $1,937,881,769.

The following table shows the approximate distribution, by States and Territories, of the silver and gold production in the United States for the year 1892. It will be seen that the bulk of the silver produced comes from seven States, Colorado alone furnishing not far from half of the total for the whole country. Nevada, which long held the first place in silver production, has fallen to the fifth place. California, which has yielded the great mass of the total gold output of the country, produces comparatively little silver. The figures given relate to fine ounces troy:

States.	Silver	Gold	States.	Silver.	Gold.
Colorado.....	24,000,000	256,387	Texas.....	310,000	.....
Montana.....	17,350,000	139,871	Washington..	150,000	18,071
Utah.....	8,100,000	31,936	Michigan.....	60,000	3,386
Idaho.....	3,164,269	83,271	South Dakota.	60,000	178,987
Nevada.....	2,244,000	76,021	Oregon.....	50,000	67,725
New Mexico...	1,075,000	45,956	All other.....	18,800	63,226
Arizona.....	1,062,220	51,761			
California	360,000	580,500	Total.....	58,004,289	1,597,098

The total estimated silver yield of the world for 1892 was 152,061,800 ounces troy, of which the United States produced over 38 per cent., and Mexico about 30 per cent., these two countries supplying more than two-thirds of the grand total. South America and Central America combined slightly exceed the Australian colonies, the product of the latter being carried up mainly by the phenomenal output of the Broken Hill district in New South

Wales. The greatest producing region in South America is Bolivia. The relatively small production credited to the European countries would be still further lowered if the amounts extracted from imported ores and furnace materials, shipped there for final treatment, were eliminated.

The present output is hardly a fair index of the relative silver-producing capacities of the several countries. As much depends upon the energy with which mining is prosecuted as upon natural resources. What the latter are it is impossible to estimate. While both the United States and Mexico have doubled their output recently, this has been because of the immense amount of effort and money that have been put into the work; and while the United States still considerably exceeds Mexico in silver production, this is no proof that our silver resources are greater than those of Mexico. In South America there has been little systematic prospecting, and the older districts, worked in the early times of the Spanish occupation, have gradually declined. To make a wild guess, the silver resources of the States through which passes the great cordillera of the Andes are probably in excess of those of either the United States or Mexico. Canada is still practically unexplored, but the probability of discovering great silver mines in the Dominion is limited to the mountainous portion. It is not likely that any increase in yield will come from Europe; the geology there is pretty thoroughly understood. China possesses some silver mines, but their capacity under more efficient working is not known. Though little exploration for gold-quartz and silver ore has been done in Asia, it is likely that any important deposits accessible at the surface would have been noticed while the gold placers were being exhausted. There is no prospect of early serious competition in the silver markets from Africa.

A study of the fluctuations during long terms of years in the value of silver, increased by equal weights of gold, reveals a fair degree of steadiness during the last few centuries and until quite recent times. In the earliest historical periods silver stood much higher, in relation to gold, as was natural in view of the relative simplicity of the means which sufficed for obtaining gold, while silver, except in the comparatively rare cases where native metal was met, had to be extracted from its ores by metallurgical processes which in their most primitive forms demanded an advanced degree of skill. There were in those days wide ranges of value in different countries owing to imperfect communication. After the dis-

turbances caused by the great influx of silver from Peru and Mexico, the ratio of the two metals settled down to a very even tenor. Toward the close of the seventeenth century the commercial ratio of silver to gold ranged between 14.83 and 15.20. In the succeeding century the extremes were 14.14 in 1760 and 15.74 in 1799. The year 1808 saw for the first time the ratio widened to more than sixteen to one (the exact figure being 16.08); and in 1818 it reached 16.25:1. Thence it remained at fifteen and a large fraction until 1874. From this date the decline has been progressive and rapid, as will be seen from the following table:

Year.	Ratio.	Year.	Ratio.
1874	16.17	1884	18.57
1875	16.56	1885	19.41
1876	17.88	1886	20.78
1877	17.22	1887	21.13
1878	17.94	1888	21.99
1879	18.40	1889	22.10
1880	18.05	1890	19.76
1881	18.16	1891	20.92
1882	18.19	1892	23.72
1883	18.64		

The average ratio for 1893 will be considerably less favorable to silver. With the price at 62 cents an ounce, which it touched in June, the commercial ratio is 33.34:1. At 70 cents it is 29.53:1.

A decline in the price of some products has a tendency to increase the output, through the attempts of the producers to maintain their net earnings by conducting operations on a larger scale. Thus a fall in prices may freeze out the weaker producers, but only stimulate the larger ones to greater activity. A notable instance of this effect is given by the copper-mining companies, of which all that were able to live have been forced to extend their operations to their highest capacity. But the conditions in silver-mining are different. It is not possible to increase the output of a given mine indefinitely, merely by putting more men and more machinery to work. As a rule, silver-bearing veins are narrow, they seldom carry ore continuously throughout their length or for great distances, and the veins generally stand at high angles,—averaging over 45°,—so that to open a mine extensively means deep mining with the added expenses of pumping and hoisting. Of the irregular contact, bedded, and "zone" occurrences of silver ore, few show very large exposures of ore bodies in any one place.

The result of this peculiarity is that no matter how well the average silver-mine may be developed—that is, opened in advance of the stopes—there is only room for a limited number of men to break down the ore, so that increasing the working force beyond a certain point would only add to the expense without a corresponding gain in output. What sense would there be in putting $20,000,000 cash into a $20,000 mine, or building a 200-ton mill for a mine supplying only 20 tons a day?

As a matter of fact, those mines which have had the advantage of a good equipment and ample capital have been worked very near to their full capacity. The whole tendency of American mining methods, in contradistinction to those of Europe, has been to push operations at the most rapid rate permitted by the means at hand and the natural conditions. In this country many a silver-mine has been worked out and abandoned in two or three years that under the old system might have lasted for centuries, though of course yielding no more metal. Increased production depends rather upon the opening of new deposits and the proper equipment of mines not yet fairly developed than upon greater activity in the mines which have hitherto been the great producers.

The purchases of silver by the United States treasury during the years 1873-92 amounted to 458,109,529 troy ounces, for which the average price was $1.0425 per ounce. The average price paid in 1873 was $1.3225, from which there was a steady decline until 1889, the average price paid in that year being $0.9356. In 1890 the treasury price reached an average of $1.0626 for the year, with a maximum of $1.20. In that year silver momentarily touched $1.21 in the New York market. The treasury price averaged $0.989 in 1891 and $0.8755 in 1892.

The average cost of producing silver cannot be stated precisely for all the American mines. It is possible to figure it out exactly for an individual mine, and to approximate the cost for a single district, but beyond this all is guesswork. My belief is that the average cost, after allowing for mining, transportation, and reduction charges, and also for depreciation of plant, sinking fund to write off original cost of mine, interest, insurance, office expenses, commissions, and other incidental expenses commonly omitted in company reports, is above the average commercial value during recent years. Indeed, considering the industry as a whole and including all the mistakes and miscalculations, all the wasted effort, all the fictitious or inflated prices paid for mining property, it is

above the United States standard rate of $1.2929 per ounce. The available opinions on this subject are necessarily from an *ex parte* standpoint. Still, these come from the men who are in the best position to know, and who, beyond question, are perfectly sincere.

In a report of the Senate Committee on Mining there is much interesting testimony. Mr. James D. Hague says the cost of production per ounce on the Comstock ranged from 35 cents (in the bonanza in the height of its prosperity) to $2.10 (for non-dividend paying mines). Taking assessments into account, the average cost of all the silver produced on the lode has been $1.10 per ounce. Taking into account losses in unprofitable enterprises, ex-Senator N. P. Hill estimates the average cost of the silver produced in the United States at $1.29 and ex-Senator H. A. W. Tabor at $1.50. W. C. Wynkoop, editor of *The Mining Industry* (Denver), secured the reports of 160 incorporated companies which produced silver in 1889, and found the cost, taking the companies which did not make a profit in connection with those that did, about $1.15 per ounce. It is stated that 99 per cent. of the silver-mining claims upon which labor has been expended have produced nothing. All this work appears to be charged up to the productive mines, as regards the value of their output. The recent Silver Convention at Denver issued an address stating the cost of producing silver at $1.29 an ounce. This expression, without qualification, excited much adverse criticism. Of course it was not meant that it cost just $1.29, no more and no less. The figure was used as a round number would be, and was so understood among miners.

It has been asked, why is there such an effort to perpetuate an industry that is, according to its own advocates, unprofitable? The answer to that is that the profitable mines have had and still have to carry an enormous dead-weight of poor mining, waste, extravagance, errors, and even swindles, when it is attempted to estimate general averages for all the mines. Silver-mining, when conducted on business lines, honestly, with good judgment and skilful management, is very profitable, if the price of the product does not fall below the critical point. With silver at $1 an ounce many mines can be operated profitably. At 82 cents, where the market halted for a long time, a smaller number can live. Below that figure, very few can make both ends meet. This is proved by the recent closing of so many of the best mines. Their managers knew when they were running at a loss. The mines which have stood the strain best are those which yield gold liberally, as well as silver.

The consumption of silver in the arts in the United States has formed the subject of an inquiry prosecuted by the Mint officials. During 1892 the government assay-office at New York turned out for this purpose 5,389,943 troy ounces of silver bars, of the coinage value of $6,966,230, and the Philadelphia mint supplied 9113 ounces. Twenty-eight private refineries, believed to include all that were engaged in this manufacture in 1892, made 1,646,281 fine bars worth $2,128,525 (coinage rate) exclusive of their "U. S." bars. Altogether, the value of fine silver bars supplied to the trade from these sources in 1892 was $9,106,540, coinage rate. Of this, over $7,000,000 worth was made from domestic bullion, over $1,000,000 from foreign bullion and coin, and over $600,000 from old plate and jewelry remelted. This was a slight reduction from the corresponding total for 1891 : $9,631,740, coining value.

Thus more than one-tenth of the silver produced in this country last year went into the arts and manufactures. Counting the foreign and old material thus absorbed here, the proportion was over one-eighth as much as the total American production. There are no statistics showing the proportion of all the silver thus absorbed throughout the world. Presumably it is higher than that shown in the foregoing computation, considering the large amounts that go into plate and ornaments in the Orient. Of the silver thus utilized, the larger part never returns upon the market. Hoardings of coin and manufactured silver, especially in India and other Asiatic countries, make a steady and heavy drain upon the production. Fires, shipwrecks, loss, and ordinary wear by abrasion account for the disappearance of another portion. As the price declines, the use of silver in the arts naturally increases somewhat. But since the popularity of silver for many uses is due to its costliness, a portion of its desirability will be lost when the metal becomes cheaper.

What will become of the silver States in case silver-mining is further curtailed? It cannot possibly be brought to a full stop, for it is too closely linked with gold-mining. Ultimately these States will recover, though very slowly, and will develop their other natural resources, beginning with the exclusively gold-producing mines. The immediate effect cannot but be disastrous; the distress that has already prevailed is an index of what may be expected. A reduced production would have a beneficial effect upon the price of silver, without doubt. It will also be possible to mine and reduce silver ores more cheaply hereafter, in accordance with the general law of progress that has obtained hitherto.

A SCIENTIFIC ANALYSIS OF MONEY.

By Emil Schalk.

MONEY, like almost all other human creations, is passing through an evolution induced by new conditions of existence. Largely increased facilities of communication not only bring into play distant countries for the production of the precious metals, but also lead from local to national and international considerations. The evolution thus going on points to a single international standard as the measure of all values, and it leads inevitably to the adoption of that substance or metal which compasses the greatest value in the smallest volume, and yet is sufficiently produced to go the round of the world. Natural, organic, and irresistible conditions of trade have led to the adoption of gold as the international standard at the present time. But it is claimed by many that, if gold is legally accepted as the universal standard of value, there will not be enough of it in sight, and not enough produced, to supply all countries with a gold currency. There is no doubt a great deal of truth in that assertion, but it applies equally to any other metal.

To solve the money problem, the question needs to be treated from a more scientific standpoint than heretofore. The devising of a system of weights and measures (and money forms part of any such system) is considered a scientific matter of the greatest importance, and is invariably referred to scientific commissions charged with carrying out the task. When France adopted her metric system, which is at the same time the simplest and yet the most scientific in existence, the commission which devised it was composed of the greatest mathematicians and astronomers of France. They established a unit of length which was called the meter, and subdivided it on the decimal plan. This meter forms the basis of all measures of surface, volume, weights, and values. A decimeter cube is called the liter, and is the unit for volumes, and the weight of a decimeter cube of distilled water at four degrees Celsius, and at an atmospheric pressure of 76 centimeters of mercury, is called the kilogram, and forms the unit of weight. The same unit of lineal dimensions was made the basis of the measure or unit of value. The gram is the weight of a centimeter cube of distilled water, and the

unit of value was fixed at five grams of silver nine-tenths fine, and it was called the Franc. The law which introduced this comprehensive system of weights and measures dates from 1801, and at that time silver was the favorite metal for money purposes, and almost all nations used it as the standard of values.

In the establishment of weights and measures, the difference between unit and standard ought to be thoroughly understood. With lineal measures but one quality is required,—that of length. For weight two qualities are required,—lineal dimensions and weight of the substance to be used as standard. There are no two substances which for the same volume have exactly the same weight. Consequently some substance has to be selected as the standard or unit for comparison. The French have adopted distilled water, at 4° Celsius, etc., as the standard, and it is so considered to-day by all civilized nations. It is the standard of comparison for the weights of all other substances on the face of the earth, and the weights thus expressed are called specific gravities and are tabulated in all scientific works.

When we come to the measure of values, we find that, besides the two qualities of lineal dimensions and weight of the substance, a third quality is required,—that of value. But by comparison of all substances with the one selected as standard a specific value is created for all those substances, exactly the same as a specific gravity. For instance, the ratio of gold to silver, gold being the standard, is like one to twenty, meaning that it takes twenty times the weight of silver to make up the value of one unit of gold. Hence it is easy to see that in a scientific money system there can be but one standard of value, just as there can be but one standard of weight. A double standard of value is just as unscientific and absurd as would be a double standard of weight.

Once a unit is fully established, it follows logically that it can be indefinitely reproduced. From the standard meter made of platinum hundreds and thousands of meters can be reproduced in all kind of material, and serve for all the daily uses of commerce and trade. In the same manner, from the standard kilogram of distilled water the same weight can be reproduced, and in any kinds of material that may be desired. The only condition is that all the reproductions must have the essential quality of the established unit and standard. The meter which is reproduced must measure exactly a meter, and the kilogram must weigh a kilogram. This characteristic of all weights and measures applies equally to

the measure of value, and in the application of this simple principle to money is to be found the solution of the whole problem. The unit and standard of value, once established, will serve to measure all other substances of value, and they in their turn may be made the basis of additional measures of value or money, up to the limit of all possible requirements.

In establishing a standard for weights, no difficulty is experienced as regards fluctuation in the weight of the chosen substance. The difference in weight between distilled water and all other substances is a fixed quantity in nature. But with a standard of value it is different. Value exists only in the mind of man. It depends on the object being more or less needed, more or less desired ; it depends on demand and supply, on whims, fashions, and sometimes on ridiculous notions, as for instance the value of tulips a couple of centuries ago during the tulip craze in Holland. It is not to be wondered at, therefore, that standards of value have greatly varied at different times and in various countries. In Homer's time cattle and sheep formed the standard. Later on iron, copper, silver, and gold were used for the same purpose. As civilization progressed, the substances most valuable in the estimation of mankind naturally were adopted as standards ; and at the present time the phenomenal improvements in the facilities of communication, the vast amount of travel, the vastly increased commerce of the world, with the necessity for settling balances of trade between nations, has led to the employment of gold as most suitable for the purpose and as having the greatest value to the smallest volume, with the least fluctuation in its value. A century ago Alexander Hamilton, in his report on the establishment of a mint, said : "As long as gold, either from its intrinsic superiority as a metal, from its rarity, or from the prejudice of mankind, retains so considerable a premium in value over silver as it has hitherto had, a natural consequence of this seems to be that its condition will be more stationary. The revolution therefore which may take place in the comparative value of gold and silver will be changes in the state of the latter rather than in that of the former." This prophecy has been justified by events. Gold has evolved naturally and irresistibly into the one international standard of value.

Most countries have a unit of value of their own, which consists of a piece of coined money differently denominated, but representing a fixed weight of the substance chosen as the standard of all values. Among all nations, civilized or half-civilized, either

gold or silver is the standard; and as far as the international relations are concerned gold alone serves as the standard. The dollar, the franc, the mark, pound sterling, ruble, etc., are the names of the units adopted in the United States, France, Germany, England, and Russia respectively. Each of these denominations of money is the unit of value in its respective country, and it goes without saying that each country has but one unit. But the value of all these units in the world's commerce is determined by the weight of gold which each is supposed to represent.

To be the measure of value, the material used for money purposes must have an intrinsic value. In itself it must be valuable property, entirely aside from being made legal tender by law. Being valuable property, and at the same time the measure of value, it becomes the generally accepted medium of exchange. The essential idea of barter is that valuable property is exchanged for other valuable property, of a different kind. By the use of money one side of the barter is always money; and as it is exchanged for other property which is measured by it, it must be as good property, in exchangeable value at least, as its face value claims to be. It must be part of the actual wealth of the nation to which it belongs. As a measure of value it is of use only for measuring other property; and as a piece of value it is of no use except for the purpose of exchange. By itself it does not feed, or clothe, or lodge, nor does it bring any income; and yet it is the synonym of all wishes. It is these peculiarities which render money a powerful factor in the progress of civilization. Without money, or with very little of it, exchanges become slow, trade and manufacture seem paralyzed, wages decline, and interest is very high: it means stagnation. Too much money, on the other hand, will stimulate exchanges to excess, advance wages and the cost of production, unduly depress interest, and overproduction and inflation will be the consequence. There must be a "*juste milieu.*" So far this *juste milieu* has not been scientifically established.

The general way of computing the amount of money necessary is to compare the amount of money per capita of each country, which, however, is very misleading. According to this method the circulation of the principal countries is as follows: France, $41.50; Holland, $28.50; United States, $25; England, $20; Germany, $19.50; Spain, $19; Italy, $11; Austria, $9; Russia, $5.

According to this list, England, Germany, and Spain have about the same amount of money per capita, yet the wealth and

commerce and general conditions of the three countries are widely different. A more correct way, at least in the sense of the present inquiry, would be to ascertain the amount of money in the percentage of the general wealth, though this method is also very misleading, as will be seen from the following figures showing the approximate proportions of money, or property used for the mere purpose of exchange, to the rest of property. Thus France has 1 unit of money to 27 units of property measured by the money unit; Spain has 1 to 31; Germany 1 to 33; Holland and the United States, 1 to 40; Russia and Italy, 1 to 42; Austria, 1 to 51; England, 1 to 60. We find here France and Spain, and Austria and England, side by side, yet the wealth, commerce, and banking facilities of those countries are widely different, so that no general conclusion as to the proper amount can be drawn from these figures.

Every country must have a proper supply of money, and it ought to be regulated according to its needs, and not be left to blind chance, such for instance as free coinage implies. But where is the money to come from? The standard ought to be a metal, and we see that the present imperative demand is for gold. How is a country to obtain the necessary amount of gold for its monetary system? There are countries which produce the precious metals, and there are others which do not. There are countries which have large manufacturing interests, and large exports, and which in course of time have become creditor nations, and are able to command gold payments. The great creditor nations have no difficulty in eventually getting all the gold they want, even if they do not produce the precious metals themselves. But debtor nations are apt to lose their gold, even if they are large producers of it. They are obliged, according to their trade balances, to pay in the precious metals which they have mined. It is an easy matter for creditor nations to establish the gold standard and to maintain a gold currency. It may be a possibility for gold-producing countries, though debtor nations, to do the same, but the question looks different for all other countries. For those the question arises, how to obtain the gold, and, when they have it, how to keep it? This problem troubles even the creditor nations, for their wealth to some extent depends on the ability of the debtor nations to pay and to keep on paying.

The solution of all the confusing difficulties is to be found in the logical application of the scientific principles defined in the

first part of this article. Money is the measure of value, and once the unit and standard are established, can be indefinitely reproduced precisely as can all weights and measures. Nobody, for instance, would think of using the platinum meter, the standard meter of France, for measuring a piece of cloth; nor would any one think of using a decimeter cube of distilled water as a means of weighing a kilogram of butter. Reproductions of those weights and measures, in wood or iron, or other material, and properly certified by the government to be correct, are used. And in the same manner, after the establishment of a unit and standard of value, there is in most cases no necessity for using the actual gold for barter or exchange. The wealth of any country will furnish innumerable objects which may be made the basis of money after being properly measured by the standard. Reproduction here is as natural as with the other weights and measures. In fact, part of the wealth of every country ought to be in that peculiar "fluid" shape of property called "money," the stimulus of all commerce.

Naturally this will lead to paper currency, in addition to the metallic, for the reason that comparatively few objects of wealth are directly capable of being sub-divided into units and stamped as correct. But such paper currency will differ from other paper currency in so far as it *represents valuable property, is the title thereto, and not a mere promise to pay.*

This will be the natural solution of the money problem, and it is the trend of evolution in the near future. In Europe several railroads have been built by means of money issues secured by the property of those roads. Here we have made a commencement by requiring the national banks to keep with the government a deposit of valuable property to the full value of their issues.

To bring about a lasting solution of the money question, at least in this country, a commission of scientific men and experts in finance ought to be appointed, to whom the whole question should be submitted for deliberate and exhaustive inquiry, and from whom a disinterested, scientific, authoritative, and practicable system may be expected. We need to follow that example which has given to France a system of weights and measures so scientifically faultless that it is destined ultimately to be universally adopted. We need, in short, the research and guidance of a body of able, distinguished, and non-partisan scientists, who will lift our whole currency system to a high plane of exact and practical science, and forever divorce the business of finance from the business of politics.

THE REAL CONDITION OF THE FARMER.

By George E. Roberts.

THE condition of the farmer in the United States, particularly in the western part of the country, has become a conspicuous subject of discussion in recent years. His mortgages, his alliances, his railway tariff-sheets, and his relations to the various political issues have been fruitful themes for economists of all grades of ability and all degrees of information. This discussion has extended to other countries, where his cheap products have been forcing a readjustment of land values and rents. Across the Atlantic people want to know whether the American farmer can continue to live and keep up this pressure of products at prices which make past rentals out of the question. And we want to know here, in these times of financial uneasiness more than ever before, the true condition of this army of wealth-producers, whose thrift is the basis of the nation's prosperity, and whose contentment is security against all alarms. Are their debts increasing, or their ability to pay diminishing? Are they falling behind financially, or are they gaining in wealth and sharing in the benefits of progress?

The farmer is not, generally, a good witness for his own prosperity. It is common for men to overrate the opportunities of other callings as compared with their own, and to unduly emphasize the hardships, or difficulties, and lack of compensation, in their own pursuits. Each is far more familiar with the drawbacks to his own business than with those which belong to others. Perhaps this is especially true of the farmer. He sees less than those who live in cities of the margins, risks, struggles, and failures of trade. His isolation serves as the distance which lends enchantment to the view. He knows that he works hard, longer hours than most other men, and that his accumulations come slowly. Whether or not a man's lot is satisfactory to himself depends chiefly on whose lot he compares it with, and the farmer too often compares his sure but small average gains with the exceptional successes in other occupations.

The rewards of business are governed by certain conditions which apply alike to farming and other occupations. We do not expect large margins in producing or handling any staple goods

for which there is always a large and ready market, or in any line of business in which competition is not somewhat restricted by the need of capital or special training. It would be contrary to the common law of competition and profits, if the profits of any business did not decline as hazard, capital, and skill were eliminated from it. I do not argue that no hazard attaches to farming, or that no capital or skill are employed in it. I wish to show, however, that the annual earnings of the farmer have been affected by the general law of compensation which in the long run takes account of all advantages and disadvantages and gives rewards accordingly. It is the western farmer, the grower of the great export staples, who has been the chief figure in this discussion, and, if we are to measure his compensation by the general rule, we must know what hazard his investment has stood and what inducements there have been for competitors to go into business alongside of him.

The first concern of every prudent investor is not for his profits, but for his principal. Where that is absolutely secure we expect the annual return to be less. Capital seeks investment where it can yield part of the ordinary return in exchange for exceptional security. Now, if there is an investment which is not only secure, but which will increase in value independent of profits, and by forces outside of its owner, it is to be expected that investors will be attracted to it, and that the *annual* earnings therefrom will be reduced. These western farms have been investments of that kind. The manufacturer who equipped his factory thirty years ago has discarded and charged to profit and loss his entire original capital by this time. The merchant who opened a store thirty years ago has lost the amount of his capital in depreciation and bad debts. Their annual profits needed to be large enough to make good this shrinkage, but the man who opened a farm in Iowa or Illinois thirty years ago has had no shrinkage in the value of his land to make good. On the contrary, if he has done nothing more than get a living from its annual return, its increased value will keep him through old age. The man who claims that farming in these western States "does not pay" always argues that the rise in the value of land is not to be counted as part of the earnings of the business. But any consideration which is sufficient to attract competition into an occupation thereby reduces its other earnings and must itself be credited instead.

Cheaper railway rates have levelled down in some of the older parts of the country as they have levelled up in the west. But in

all of that region which has been settled in the past thirty years, and whence come our grain exports, there has been a large advance in the value of land, and the certainty that such advance would come has been a factor in its development and in the resulting price of farm products. The history of Ohio, Indiana, and Illinois was a guaranty that a good homestead entry of 160 acres west of the Mississippi would within a lifetime be worth more than the average life-savings of a mechanic or laborer. And so these cheap lands filled up, not simply for the annual profits of the farm, but to secure the rise,—the "unearned increment." Twenty years ago Edward Eggleston put the sentiment of the times as to land into the mouth of one of his Hoosier characters when she said, "Git a plenty, while yer gittin." That has been the policy; not to take a small farm and cultivate it highly, but to spread over as much land as possible, by the aid of modern machinery, raising the few staples which would bring quick returns, and mortgaging all that could be paid for to buy more while it was cheap.

The United States census of 1860 called attention to the rapid advance in the value of lands which was following the opening of new railroads. Here is an extract from the census report:

> The influence of railroads on the value of farming lands is too great and striking not to have been noticed by all intelligent persons. We have, for example, the immediate effect produced on the lands of Illinois by the Illinois Central railroad. That company received from the government a large body of land at a time when the government could not sell it at $1.25 per acre. Since then the company has constructed its road and sold a large part of those lands at an average price of $11 per acre, and the greater part of the lands of Illinois are worth fully that. Notwithstanding the rapid growth of population, the larger part of this advance is due to railroads. The following table shows the advance (by the census tables) of the cash value of farms in the five States mentioned, in the ten years, 1850 to 1860:

	1850.	1860.
Ohio	$358,758,602	$666,564,171
Illinois	96,133,290	432,531,072
Indiana	136,385,173	344,902,776
Michigan	51,872,446	163,279,087
Wisconsin	28,528,563	131,117,082
Total	$671,678,074	$1,738,394,188

> We need not pursue this subject further. If the effect on the central western States has been so great, it is still greater in the States which lie beyond the Mississippi. They are still farther from market, and will be enriched in a greater ratio by the facilities of transportation.

At the time this was written not a mile of railway existed within the boundaries of the present States of Minnesota, North Da-

kota, South Dakota, Nebraska, and Kansas, and only 655 miles in Iowa. In 1890 there were 32,988 miles in these States (more than the total mileage in the United States in 1860), and the history of rapid development and advancing land values in the central western States, as prophesied in 1860, had been outdone.

With this security for investment and assurance of increased value in the future, is it to be wondered at that the stimulus given to farming resulted in low *annual* earnings? We have eliminated risk from the investment; now let us see how small was the investment needed, and how little the training or the skill involved, in opening a prairie homestead and producing a crop of grain. There is ample room for skill and management in farming, but the farming which has filled our markets with wheat, corn, and oats has been done by main strength, and the price of these grains has tended downward to that measure of pay.

We threw open our gates to the whole world, offering a homestead to every family that would occupy it. The railroad companies flooded Europe with agents inviting settlers, and millions of industrious people accepted the invitation. The number of acres of improved land in Iowa, Minnesota, Kansas, Nebraska, and the Dakotas increased from 4,875,414 to 44,507,915 between 1860 and 1880. The people came not so much for the immediate returns from these farms as to get homes. Their reasonable expectations have generally been more than realized, although there have been many years when the enormous production thus stimulated has made the prices of products discouragingly low. Is this not what might have been expected?

The census reports show how the production of the staples of these States has increased faster than the population of the country. These figures give the total production of grain in the United States to each inhabitant of the country, for the years named:

	1849.	1859.	1869.	1879.
All grains, bushels...	37.32	39.41	38.57	53.79

The great increase was between 1869 and 1879, the period of greatest depression of prices. The census reports for 1890 have not been completed, but it is known that the gain of products upon population has ceased. The cheap lands are gone. The period of artificial stimulation has passed. The man with only a team of horses and a plow as capital can no longer open a new farm. This change in conditions may bring other problems, but the condition of the man who owns 160 acres of good farming land in this coun-

try will soon cease to disturb anybody but the single-taxers. I do not wish to convey the idea that no money has been made in farming except by advance in land-values, but to show that those who did the plain work of raising grain in competition with free lands could scarcely expect different results. But all over the prairies the improvements upon farms, new houses, larger barns, growing herds, are visible evidences of the steady accumulation of wealth.

Against the showing of homes secured and wealth created in farm values, there can be but one offset to sustain the claim that these western farmers have not prospered. That is their indebtedness. Are they secure in these homes? Has this increase in land values inured to their benefit, or is it offset by mortgages made to pay living expenses? Some people regard all debt as an unmixed evil, and in estimating the prosperity of a community they treat the mortgage as the most significant and conclusive fact to be considered. But every one familiar with growing cities or a new country knows that a mortgage does not necessarily mean that the maker is becoming poorer. Almost all of the farms in the western States are owned by men who began life upon them with small means. They obtained possession by small cash payments, giving mortgages for the balance. Even in the older States the passing of property from the elderly and well-to-do to the young and ambitious gives continual occasion for the same class of mortgages.

Wherever values are advancing it is the common practice of investors not to avoid mortgages but to make them as large as possible and spread their ready money over as much land as possible. The man who has enough cash to buy 80 acres and own it free of debt, in times of prosperity prefers to buy 160 acres and give a mortgage for half the sum. These people who argue from mortgages alone would use the latter case to prove that the man was in distress, whereas it was his confidence in his own and the general prosperity which occasioned the mortgage. Chicago has been one of the most prosperous cities in the world. The owners of real estate there have been among the luckiest people, and yet from 1880 to 1889 the mortgage debt incurred in Cook county increased five-fold. In 1890 that indebtedness in Cook county was $161 per capita, while for the rest of the State it was only $73. The increase in population in Cook county during the last decade was 97.19 per cent., against a general increase of 24.86 for the whole country. St. Louis presents the contrast of a city whose growth has been only slightly greater than that of the whole country, the

percentage during the decade being 28.89. Its mortgage indebtedness in 1890 was $91 per capita, or but little more than one-half that of Chicago. It cannot be concluded from this fact that St. Louis has been more prosperous than Chicago, but that is the logic of the hue and cry about farm mortgages.

The men who began on farms without capital were obliged to do without equipment and improvements very desirable to have, and which they strive to get as early as possible. Most of them began without shelter for either crop or live stock and very poor shelter for their families. As they prosper they prefer to make these improvements rather than pay the mortgage. Or, as the boys grow up, and they see land advancing in value, they want the piece that joins them. So the mortgage stands, or is replaced with a new one drawing 6 or 7 per cent. interest, instead of 10 per cent. This mortgage signifies investment, not distress.

The last census embraced an exhaustive inquiry into the subject of farm mortgages, the result completely disposing of the theory that they are made to pay losses in farming operations. Here is a summary of the census report for Crawford county, Iowa, which is a fair sample of the general showing on the subject:

Object of Indebtedness.	Per cent. of total amount.
Purchase money	64.11
Improvements	10.29
Purchase and improvements	9.61
Improvements and farm stock	1.87
To buy more land	1 87
Outside business	4.45
Farm expenses and property	2.88
Farm and family expenses	1.12
Purchase, farm expenses, and property	.97
Purchase and other objects	.50
Improvement and other objects	.46
All other objects	1.87
	100.00

The detailed report is more convincing than the summary, as it shows more particularly the cause of the small percentage of mortgages which stand for home and farm expenses. Sickness and death in their families, loss of crops by storms, epidemics among live stock, and similar misfortunes, coming upon men without reserve means, account for a good proportion of these. From 2 to 5 per cent. covers the proportion of mortgages given to make up

farm and family expenses in the States having a greatest showing of mortgages. It is doubtful whether any other line of business can give a more satisfactory account of its debts.

The newer States show a larger percentage of mortgaged land than the older ones. In the table herewith are presented some comparative facts regarding farm mortgages in four prairie States, with the date of the creation of each State. The table shows:

I.—Percentage of total number of acres under mortgage.
II.—Average mortgage indebtedness per mortgaged acre.
III.—Estimated average value of all farm lands.
IV.—Percentage of partial payments upon mortgages at the date of the census.
V.—The average life, in years, of a farm mortgage.

States.	I.	II.	III.	IV.	V.
Illinois (1818) ...	30.78	$15.50	$35.95	11.71	4.0
Iowa (1846).....	46.95	9.17	23.96	12.25	4.9
Nebraska (1867)..	58.13	6.43	14.45(a)	5.21	3.2
Kansas (1861)....	61.56	6.57	13.83(a)	5.00	3.3

a. The averages of value in Nebraska and Kansas are much reduced by the large areas of low-valued lands in the western halves of those States.

The last column in this table does not signify that farms have been cleared of debt by this time, for there is a constant shifting as better rates of interest or other considerations induce. The partial payments usually are made from farm earnings. They should be considered in connection with the average life of the mortgages, but they fall far short of showing the surplus earnings, because there is a constant investment of surplus in betterments.

It would help to a knowledge of the condition of a State to know where its mortgage indebtedness is held, but the census bureau found this difficult to arrive at. In four Kansas counties it was found that about 45 per cent. of the mortgages ran to residents of the State, excluding mortgage companies and loan agents, and the commissioner believes this a fair basis to judge the State from. In the older States undoubtedly a much larger proportion of the money borrowed is supplied by residents. The Auditor of State for Iowa estimates that 75 per cent. of the deposits of the State banks, which are under his supervision, belong to farmers. If he is correct, the bank deposits of farmers in Iowa, including national banks, are sufficient to pay all of the mortgages on Iowa farms. At a valuation of $77 per head the horses on Iowa farms would pay the entire farm mortgage debt.

To one who knows anything of the risks and anxieties of trade, the constantly narrowing margin of profits, and the pressure of competition, there is a security and certainty in the farmer's position which deserves to be more highly valued than it is by many who possess it. House rent and food the farmers have as a matter of course, and they scarcely think to give the farm credit for it. If times are hard, the outgo can be made exceedingly light. If well farmed, the land must increase in value, now that the arable parts of this country are so fully occupied. The population increases rapidly. Improved methods of culture will constantly increase the yield of a given acreage, and perhaps so rapidly that prices may not rise, but either in an increased product or an increased price the restricted acreage must effect better results for the farmer.

The productive capacity of each farm-laborer increases annually by the aid of labor-saving machinery, while the cost of farm- and living-supplies is decreased by the constant fall in prices of manufactured goods. One man riding a self-binding harvester, which now costs in Iowa $125, does as much work in a wheat-field as six men with a machine which cost more money could do twenty-five years ago. The prices of farm products at this writing are depressed by a period of extraordinary financial stringency, but there has been no such continuous decline as in manufactured goods. There has been no decline that is not accounted for by an increased supply. The average of Chicago prices on corn, oats, and wheat for the past decade is but slightly under the average from 1870 to 1880, or even from 1860 to 1870, if these are reduced to a gold basis. In the far west, where drouth makes crops uncertain, the farmer is of course taxed with risks for which he gets no compensation, unless it be in cheaper land, for he must sell his products in the common market. But in the region of sure crops the farmers as a class are the safest people in the world to do business with, to sell goods to, or to loan money to. No other class of people buy or borrow so little in proportion to their means. Their products may at times be low in price, but they can always be turned into money, they always swing back to a fair price, and they do not go out of style. The country districts where banking and merchandising are based immediately upon agriculture have been comparatively tranquil throughout the excitement of the past three months. Continued hard times elsewhere will affect them, but the market is world-wide, and the allowance for food the last to be reduced.

There always has been, and there still is, a great deal of hard

work about farming. Its isolation, the consequent absence of social pleasures, the lack of stimulus to mental culture, and lack of time for it, have always been pathetic features not to be ignored. They have sent the ambitious boys to the cities in droves, and made life a dreary round of drudgery to many women. But the conditions of life in this respect are improving. The creameries have taken the butter-making out of the farm-house, and machinery has dispensed with the drove of harvest hands that formerly had to be fed with the help of the farmer's wife. The cottage-organ, the spring-wagon, and the top-buggy are now to be found on farms everywhere, and they signify more thought for comfort and easier circumstances than of old. The district and graded schools are much better than formerly.

We can only guess what telephones and electricity may do to break down the isolation which has been an unfortunate feature of farm-life, but we can imagine much. Strange as it may seem, the greatest discouragement to the farmers in recent years has been the difficulty in getting trustworthy help. There has been a great scarcity of men and women to work on the farms and in the farm homes. The reason is that they crave the excitement of city life.

One of the representative farmers of Iowa is the Hon. L. S. Coffin, of Webster county. He has been a member of the State Board of Railroad Commissioners, and connected at one time or another in an official capacity with the several State agricultural organizations. He recently furnished a reply to a series of inquiries from the Senate Committee on Agriculture, from which I have been permitted to copy the following paragraph:

> All my life I have been a farmer; came to Iowa empty-handed; am now well-to-do; have a large beautiful farm of 720 acres; well stocked with full-blood cattle, hogs, and sheep; out of debt; borrowed some money to start with after I had opened my first quarter-section; am now seventy years old. There is no general avocation in this State that is so sure of good fair returns as farming. My best judgment is that nine out of ten of the well-to-do farmers of this State commenced life as I did,—as a hired hand. . . . My opinion is formed from long and close relations and observations that in this State not less than 95 per cent. of our farmers make a success of farming, and in the end find themselves well fixed for old age, and to-day, with the uncertainty spoken of above as an exception, we never were so prosperous as an agricultural State as now.

Such testimony could be so abundantly produced as to completely overwhelm the pessimistic views spread abroad by people who as a rule have theories to support or axes to grind,—and are devoted to these purposes rather than to the welfare of the farmers.

THE FALLACY OF MUNICIPAL OWNERSHIP.

By M. J. Francisco.

THE subject of municipal ownership of lighting plants is at the present time attracting widespread attention. Statements favoring such control have been made, in which serious errors appear, calculated to mislead the public in regard to the cost of electric lighting. These statements have been made by parties whose interests—and in many cases their positions—have depended upon a favorable report of the cost of the lights. Nothing is easier than to make the claim that municipalities can and do furnish lights at lower rates than private companies, but no attempt is made to prove the assertion, and mere words are not evidence. Not an instance can be shown where municipalities have furnished the lights at a less cost than private companies, if all the expenses are considered and the facts are candidly stated.

There are many intelligent men who are opposed to the scheme, because of the political dangers to the nation and State and to municipalities themselves in this attempt to control private industries. No sober-minded citizen can fail to recognize and admit the objections to the plan, and no one will pretend for a moment that it is not surrounded by grave difficulties and uncertainties. Consider for a moment the effect if all the capital and employés of the railroads, telegraph, telephone, and electric-light companies were placed under government ownership and control. Not only would an indebtedness be created almost beyond the limits of computation, but an army of employés whose magnitude would dwarf the combined military forces of the world would be added to the political machine. Even the strongest advocates of municipal ownership must admit the danger of such an army of employés subject to the manipulation and control of any political party. The principle advocated in municipal control is the same as in national control, only upon a smaller scale, and the result can be traced even in insignificant municipalities where it has been tried.

Private companies are not paid a proper price for lights at the present time, as is shown conclusively by the fact that thirty-three of fifty-six electric-lighting companies doing business in Massachusetts could not pay any dividend, while the average dividend

paid in one year by the whole fifty-six companies was only .0235 per cent. If private companies, with all their skill and close business management, can barely pay expenses at present prices, how can a municipality be benefited by engaging in the business, while relying for service and information upon politicians and municipal managers lacking experience and changed at every election? Even where the officials are honest in the performance of their duty, they are, in the words of ex-Mayor Hewitt, "constrained and overruled and compelled to reward political service by public office."

It is conceded by all who have had experience that an electric plant requires the most careful attention and all the skill and sagacity that can be secured to make it a success, even when conducted by men who are financially interested in it, who feel in their pocket the cost of every expenditure, and whose entire fortune may depend upon its successful management. It is admitted that a man pays closer attention to business details and economy where he has the most at risk. In all municipal enterprises there is a lack of attention to mechanical and other details which must be carefully watched and guarded in order to insure success. No sane or fair-minded man will, with the corruption and fraud practiced by politicians at the present day, attempt to prove that it is for the best interest of the taxpayer to place faith in the honest or conservative management of any enterprise which can be manipulated in the political arena for the advancement of the men in power. Human nature is the same the world over and will be forever. The best guide of what the future has in store is a comparison and study of the past. The histories of New York, Philadelphia, and many other cities are samples of what will be done for political preferment. In every case the records show that it has been for the best interest of the citizen and taxpayer to contract with an electric-light company for lighting streets.

Where a municipality owns the plant there are many ways by which the cost can be reduced apparently besides the practice of true economy. Officials see no necessity of inaugurating strict business methods when a plausible statement that there is a reduction satisfies the public. The cost of lights under municipal ownership is not always correctly reported to the committees and city officials who are investigating the subject. An examination of the reports given to representatives of Mobile, Scranton, Milwaukee, and Steubenville, by the authorities at Little Rock, Chicago, Ypsilanti, and Aurora, shows that no two reports from the same place agree.

The authorities at Ypsilanti reported to the committee from Mobile that the cost of their lights was $33 79 ; to the committee from Scranton that it was $23.61 ; and to the committee from Milwaukee, $37. Then the Steubenville committee were informed that the cost was $40, and in the last report to the mayor of Watertown they state it costs $46 per lamp per year, or double the cost reported to the Scranton committee. The same variations are found in reports from other cities owning plants. If the records and accounts are properly kept, why do not these reports agree? The advocates of municipal ownership claim that the city of Philadelphia is making money on its gas-plant, but the committee sent there by the Massachusetts legislature made an investigation and reported that Philadelphia was losing $106,144.26 per year in running her municipal plant. The folly of small cities loading themselves down with debt to install a municipal plant has been illustrated time and again. In addition to the tax to be levied for the payment of interest and principal, there is the annual expense of running the plant and repairs to be made, thus placing a burden upon its citizens which cannot be overcome in years, besides driving would-be citizens away on account of the heavy taxes caused by these debts and expenses.

Many cities have been induced to adopt municipal ownership under false impressions. Their councilmen were deceived by the statements regarding the cost, supposing the figures furnished by municipalities owning plants to cover all the charges. After adopting the plan they found that electric lights could not be run as successfully or as cheaply under municipal control as when furnished by private companies. They are, therefore, trying to unload with as little loss as possible. In illustration of this the experience of Greenville, Carrollton, Hope, Stockton, Lyons, Marcaline, Michigan City, and Portland, which have tried and abandoned municipal ownership, may be cited.

In the list of cities quoted by the advocates of municipal ownership, the price per year in a place using water-power and only running twenty nights a month, until midnight, is compared with the price of private companies using steam-power and burning all night and every night in the year. Then the reason given for the difference in price is that in one city the municipality owns the plant and in the other it is furnished by a private company. The liability that a city assumes when it owns a plant is never included in the estimate, and the armatures destroyed are not reported as

an expense or loss; neither are the accidents reported, though in many cases these may cost thousands of dollars.

An investigation of twenty-nine city-owned plants shows that the average cost per hour is 0.564 and the average candle-power per hour for 1 cent is 361. A like comparison of 29 private plants furnishing lights under contract shows that the cost averages .0374 per hour, and the candle power per hour for 1 cent is 576. This investigation shows that in nearly every case the cost per hour, where a contract is made with a private company, is less than when light is furnished by the municipality; also that the candle-power for one cent furnished by the private company is more than that produced by the municipal plant.

Reports from a large proportion of the municipal electric-lighting plants in the United States demonstrate that the average cost per lamp per year is $16.46, while the average candle-power per hour furnished for 1 cent is 402. Like reports from 1000 electric-light companies, embracing both steam- and water-power plants, and furnishing lights under contract, show that the average price per lamp is $100, the average cost per hour .0357, and the average candle-power per hour furnished for 1 cent, 560. By a comparison of these two classes of reports it will be seen that the average price under municipal ownership is $16.46 per lamp more than it is where contract is made with a private company; also that the candle-power per hour furnished for 1 cent is 158 less when furnished by municipalities than when private companies are producing the lights. In the reports of cost of lights where the municipality own the plant all of the expenses are not given, and in many cases part of the expense is charged to other departments and no allowance is made for interest, depreciation, taxes, or insurance, though these are items that practically affect the taxpayer as much as the bills for coal.

The municipal plant at Allegheny, Pennsylvania, suffered a loss by fire, and, when the insurance was paid, the city officials deducted the amount paid by the insurance companies from the running expenses, claiming that the balance was the cost of running the lights. The query arises: if this plan is adopted, how long will the buildings last, and must they burn one every year to make the expenses correspond with the present report? Danville, Virginia, lost an armature costing $500, and then the station burned, and there was a loss of $9000, as the property was not insured. Can you find any reference to these losses in

the reports that are being circulated regarding cost of lights in Danville? Yet they are part of the cost to the taxpayers. In Bay City, Michigan, a report was made to the taxpayers, in which it was shown that the expenses of 150 lamps for one year was $11,683.03. They also stated in the same report that "the actual cost of a light for one year was $46.20,"—that is, under municipal ownership, when you divide $11,683.03 total expense by 150,—number of lamps,—the quotient is $46.20! This is a sample of municipal bookkeeping.

Danvers, Massachusetts, has been cited as an example of the success of municipal ownership. Upon an examination of the town report we find the lights are only run 1500 hours per year, cost .0568 per hour, and only furnish 211 candle-power per hour for 1 cent. The expense of the legislative committee, amounting to $1635.84, is charged to construction; how much can the town realize from this item as an asset? Easton, Pennsylvania, is another city where municipal ownership has been tried. The mayor in his last message said: "In Easton the cost is claimed not to be over $87 per year, but both the city treasurer and controller, who are familiar with the subject, claim that the cost is far in excess of these figures, and may reach the highest figures of any city which owns its own plant." An examination of their business demonstrates that the cost is $147.22 per lamp per year, and .0457 per hour, only furnishing 437 candle-power per hour for 1 cent.

In an article in the *Review of Reviews*, Hannibal, Missouri, was cited as affording an instance where the benefits of municipal ownership were apparent. They had a cyclone which damaged the station badly, and the repairs cost $711.88. Instead of charging this to repairs, where it belonged, they charged it to construction account. In this way taxpayers were led to believe that they had improved the building that much, whereas they had only repaired the damage caused by the cyclone. Clearly the money thus expended was a loss, and should have appeared in the loss or expense account. They have burned out five armatures, and the claim is made that these were destroyed through ignorance and carelessness, but this must be expected where management is controlled by the results of an election.

Referring to the table given in the article in the *Review of Reviews*, we find, under the heading of prices paid to private companies by cities for lights, that Sedalia, Missouri, running on "moon schedule," the same as Hannibal, is furnished 2000 candle-

power lamps for $87 per year, the cost being .0397 per hour, giving 564 candle-power per hour for .1 cent. Thus it will be seen by their own table, where they give the price of private companies, that Sedalia is receiving 134 candle-power more per hour and at a cost of .0143 less per hour than Hannibal, after crediting the latter place with the income they receive of $4000.

In Marietta, Ohio, the lights produced by the municipal plant cost .0589 per hour, furnishing 339 candle-power per hour for 1 cent. The city superintendent also has charge of city buildings, prison, and fire-department, and his wages are charged to those departments; the city prisoners are also used for handling coal. Parkersburg, West Virginia,—only twelve miles from Marietta,—is supplied with lights by a private company for .0265 per hour, being .0324 per hour less than it costs Marietta. In addition, Parkersburg receives 754 candle-power per hour for 1 cent, getting more than double the light that Marietta does, at less cost.

Peabody, Massachusetts, established a plant, and in four months' time discovered how $12,107.43 (the expenses) could be divided by 146 (number of lights) and show a yearly cost of lamps of only $68.72. This system of mathematics will work successfully only under municipal ownership. In their assets are included $1500 paid for court expenses, and $500 expenses before legislative committee. In addition, there are salaries, attorney's fees, rent, and other items of expense, amounting to $3752, charged as assets, but which belong in expense account.

Can any one produce a statement showing the cost of municipal lights in Topeka, Kansas, that includes twelve armatures they have destroyed, costing $4800? Ypsilanti, Michigan, in 1890 had running expenses of $2500; now they are $3800, and steadily increasing. The authorities were asked if, with their experience, they favored cities doing their own lighting. They answered "no," for political preferences and frequent changes of management are too expensive,—incompetent engineers, linemen, and trimmers are kept in place by a committee for political or other purposes; and poor carbons, lack of attention generally, grounding of wires, breaking of globes, and constant repairs, make this system expensive and the cost an unknown amount until the year expires. All kinds of complaints and no responsible head is the rule.

This is municipal ownership, the new political machine of the nineteenth century.

STEAMBOATING IN THE WEST AND SOUTH.

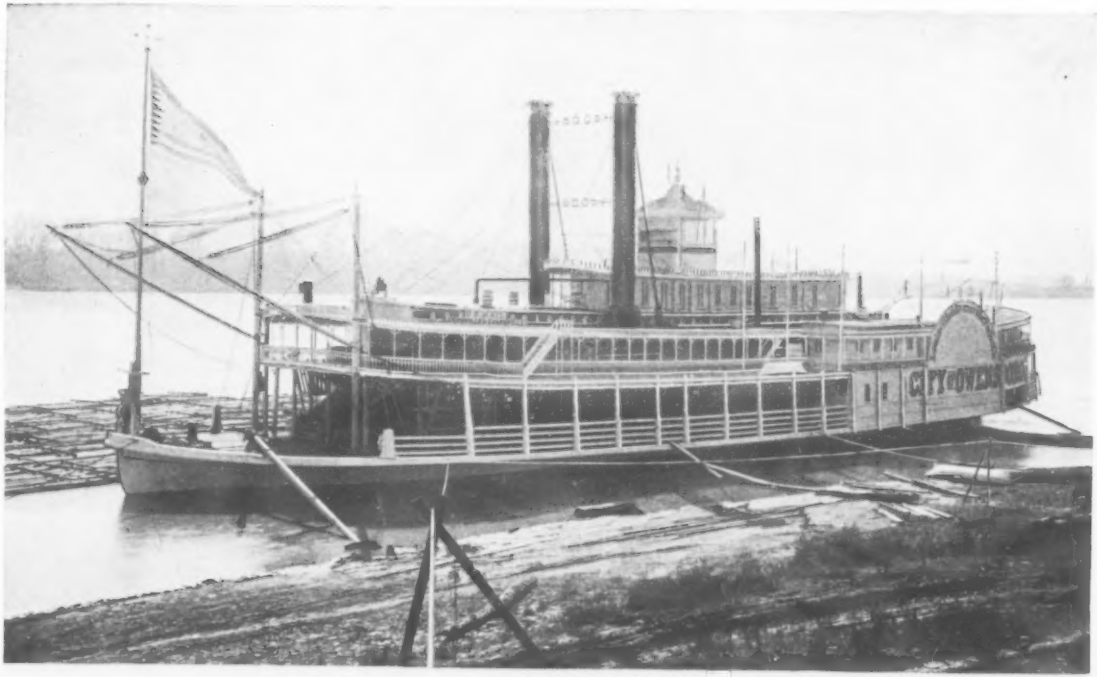
By Walker Kennedy.

STEAMBOATING on the Mississippi and other western and southern rivers in the United States is in a state of arrested development. There was a time when the river-transportation interest boasted a certain splendor, but this for the most part has passed away. The railroads have made this deterioration inevitable, since in this more energetic era quick transit is the object in view of every traveler. Only a small percentage of passengers now go in search of the picturesque, and these are satisfied if what they seek is found at the end of their journey. When there was no way to go from Louisville, or St. Louis, or Memphis, to New Orleans, except by water, and when no means existed for shipping western farm products through Atlantic seaports, the importance of river transit was necessarily very great. Magnificent boats were built, in keeping with the monopoly and the magnitude of the traffic on the Mississippi. The proud owner of a steamboat then put frequently as much as $150,000 or $200,000 in it, whereas now he would hesitate to invest $75,000. Before the civil war, and for several years after, boats went down the river carrying often as many as 10,000 bales of cotton. Now 3500 bales are considered about the limit. The floating palace has given place to the trim, plain, business-like steamboat, and the glory of the river has in a measure departed. But in late years there has been some indication of an improved state of affairs, and under conditions more favorable it is not improbable that the river will again become the most popular channel of travel in the Mississippi valley. Some probability of this is fairly deducible from the figures supplied in the "Statistical Abstract of the United States" for 1892, prepared under the direction of the Secretary of the Treasury. In 1878, for instance, the number of boats built on the Mississippi river and its tributaries was 460, with a tonnage of 68,928. From that year there was a steady decline in steamboat-building until 1886, when the number fell to 76, with a tonnage of only 10,595. Since then there has been an upward movement, as the table on the following page will show :

Year Ending —	Vessels built.	Tonnage.
June 30, 1886	76	10,595
June 30, 1887	79	10,901
June 30, 1888	84	11,859
June 30, 1889	83	12,202
June 30, 1890	104	16,506
June 30, 1891	114	19,984
June 30, 1892	99	14,800

It will be seen that in the first six years under review the number of steamboats built on the Mississippi and its tributaries nearly doubled, and that the tonnage came still nearer an increase of 100 per cent. While the figures for the last year for which official statistics have been compiled shows a falling off, it is worthy of note that boat-building on the great lakes was depressed almost as perceptibly during the same years as was boat-building for the rivers. The tonnage built on the lakes and on the entire seaboard was smaller during 1892 than for the preceding year, after having increased steadily for a few years previously. From unofficial sources there is reason to believe that the present year will make a better showing, and that the river-men are justified in hoping that their trade may yet experience the same vigorous impulse that has been felt in the lake shipping trade.

The first steamer on our western rivers was the *Orleans*, built by Fulton and Livingston at Pittsburgh, in 1811. It was a boat of about 200 tons burden, and its first trip was made from Pittsburgh, down the Ohio and Mississippi rivers, in December, arriving at New Orleans on Christmas evening. It was a stern wheeler, rigged with masts for sailing. It had no guards or upper works, and but one chimney, with the pilot-house in front. The speed of the craft was about three miles an hour. The next boat was the *Comet*, a stern-wheeler with vibrating engines, which were subsequently utilized for a cotton-factory. The *Enterprise*, a boat of not over 50 tons burden, built at Brownsville, on the Monongahela, was the first boat to make a direct trip from New Orleans to Louisville, in 1815. It took twenty-five days to make the trip, or about one-third the time in which one may now travel around the globe. The *Washington*, the first two decker, was built at Wheeling, West Virginia. Its boilers were located on the deck instead of in the hold, as had previously been the custom. In 1817 this boat left Shippingport (now a part of Louisville) for New Orleans, and



"CITY OF OWENSBORO," IN THE LOUISVILLE AND EVANSVILLE TRADE, OHIO RIVER.

[Built at Howard's Shipyard, Jeffersonville, Ind., in 1885. Length, 240 feet; beam, 38 feet; hold, 6 feet.]

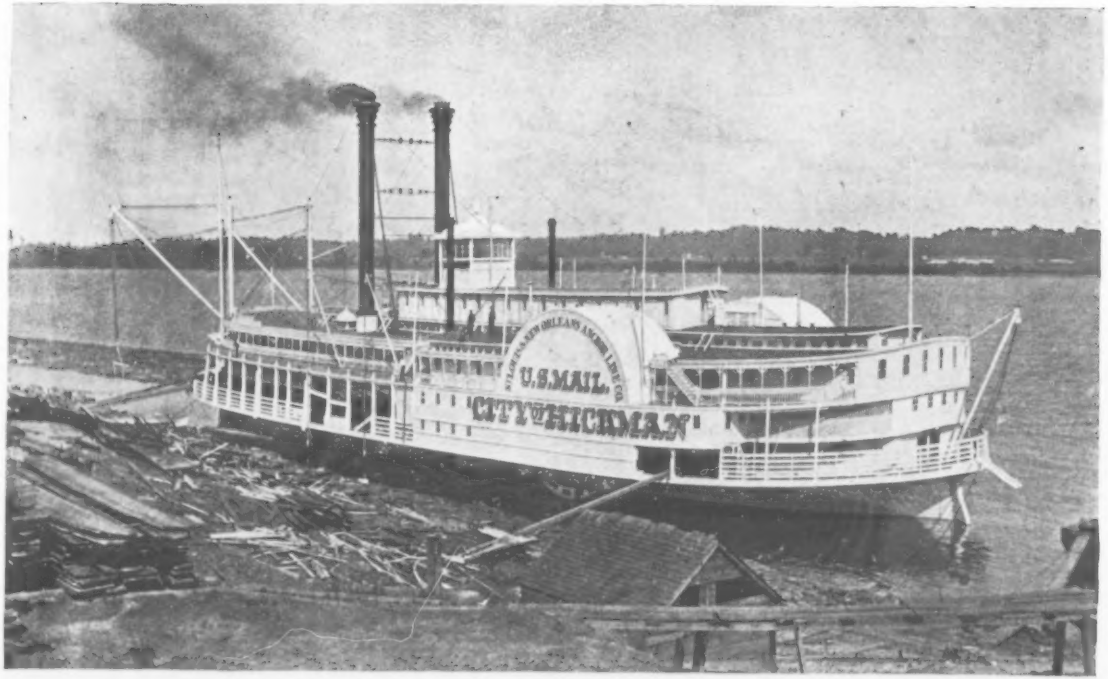
returned in forty-five days, thus demonstrating the success of river navigation.

Several boats were built between 1816 and 1818, which it is not necessary to recall, having possessed no peculiarities entitling them to specific mention. In 1818, however, was built the *General Pike*, the first steamboat on western waters for the exclusive convenience of passengers. She was constructed in Cincinnati, and her measurements were 100 feet keel, 25 feet beam, 40 feet length of cabin, and 24 feet breadth. At one end there were six and at the other eight state-rooms, divided in the middle by a passage, leaving in the center a hall, 40 by 18 feet, for the accommodation of passengers. The *Expedition* (120 tons) and the *Independence*

"JOHN W. CANNON" ON THE WAYS AT HOWARD'S, 1878.

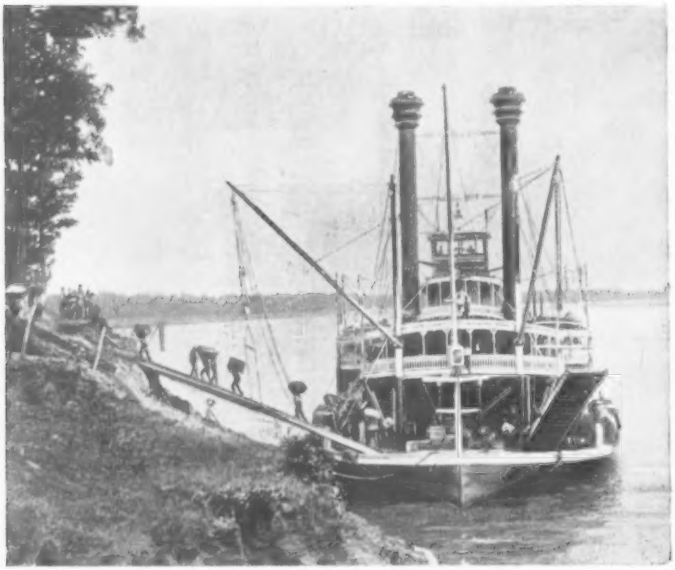
This boat and the "J. M. White" were the two finest steamers ever built in the west. Length, 292½ feet; beam, 42 feet; hold, nine feet five inches. Cylinders, 34 inches; stroke, 9 feet; seven boilers.

(50 tons), built near Pittsburgh, were the first steamboats to stem the current of the Missouri river. The *Maid of Orleans* (100 tons) was a schooner-rigged steamboat, which sailed to New Orleans, and then steamed her way up the Mississippi to St. Louis, being the first boat that ever reached that city from an Atlantic port. In 1838 the *Diana* obtained from the Post-office Department a premium of $500 in gold for the distinction of being the first boat to make the trip from New Orleans to Louisville in less than six days. In 1846 the *Greek Slave*, built for the Tennessee-river trade, was the first boat to use the steam capstan. In 1851 the far-famed *Southern Belle* was built for the Vicksburg trade.



"CITY OF HICKMAN," IN THE ST. LOUIS AND NEW ORLEANS TRADE, MISSISSIPPI RIVER.

[Built at Howard's Shipyard, Jeffersonville, Ind. Length, 311 feet. Cost $125,000.]



MISSISSIPPI STEAMER AT A COTTON-PLANTATION.

She was 241 feet keel, 31 feet beam, and 8 feet hold, and had the finest cabin ever seen up to that day. The *C. D. Jr.*, built in 1853 for New Orleans and the Bayou La Fourche, was the first boat that had a freight-hoisting engine. In 1854 the Howards, of Jeffersonville, Indiana, built for the Bayou Sara trade the *Capitol*, the fastest boat in the southwestern country. She was 235 feet in length, 35 feet beam, 8 feet hold, and had 30-inch cylinders, with 9 feet stroke and 6 boilers. The *J. A. Cotton* was built in 1860 for the coast trade. She had low pressure engines and was fleet as the wind.

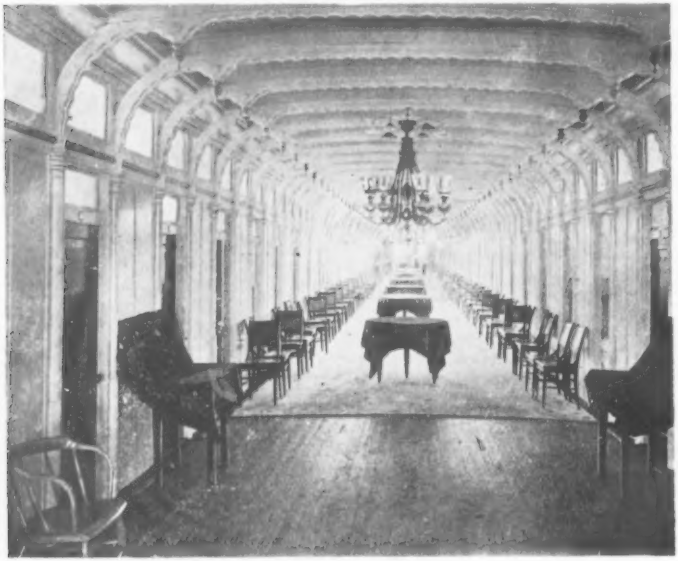
During the war (1861–65) there was of course a hiatus in steamboating, but after it a number of magnificent boats were built. The largest boat before the war was the *Eclipse*, launched in 1852, which was 363 feet long, beam 36 feet, and the hold 9 feet. It had eight boilers, 32½ feet long and 42 inches in diameter. Its engines had a diameter of 36 inches and a stroke of 11 feet. The diameter of its water-wheels was 41 feet, and its buckets were 15 feet. After the war, the finest and the largest boats built were

A COTTON-BOAT—THE "C. E. SATTERLEE."
Built by the Howards, at Jeffersonville, Ind., for the Texas and Pacific Railway. Length, 180 feet; beam, 35 feet; hold, 4½ feet.

the *R. E. Lee*, 200 feet length, 44 feet beam, and 10 feet hold; the *Frank Pargoud*, 250 feet length, 41 feet beam, 9½ feet hold; the *Natchez*, 301½ feet length, 42½ feet beam, and 9½ feet hold; the *R. E. Lee* again, 315 feet length, 48½ feet beam, and 10½ feet hold; the *John W. Cannon*, 250 feet length, 43 feet beam, and 9½ feet hold; and lastly, the *John M. White*, the model palace steamer of her time, built by the Howards of Jeffersonville, in 1878, for the New Orleans, Vicksburg, and Greenville trade. This boat was in some respects the acme of achievement in steamboat-building. The *Eclipse* had been a passenger boat, and it is said that she never made a cent for her owners. The *White* was not quite so long as the *Eclipse*, but she was a larger boat and was much more elaborately and powerfully equipped; and she carried both freight and passengers, and proved a handsome investment. Her length was 321 feet, beam 50 feet, hold 11½ feet, making a volume of 173,075 cubic feet, as against 117,612 cubic feet for

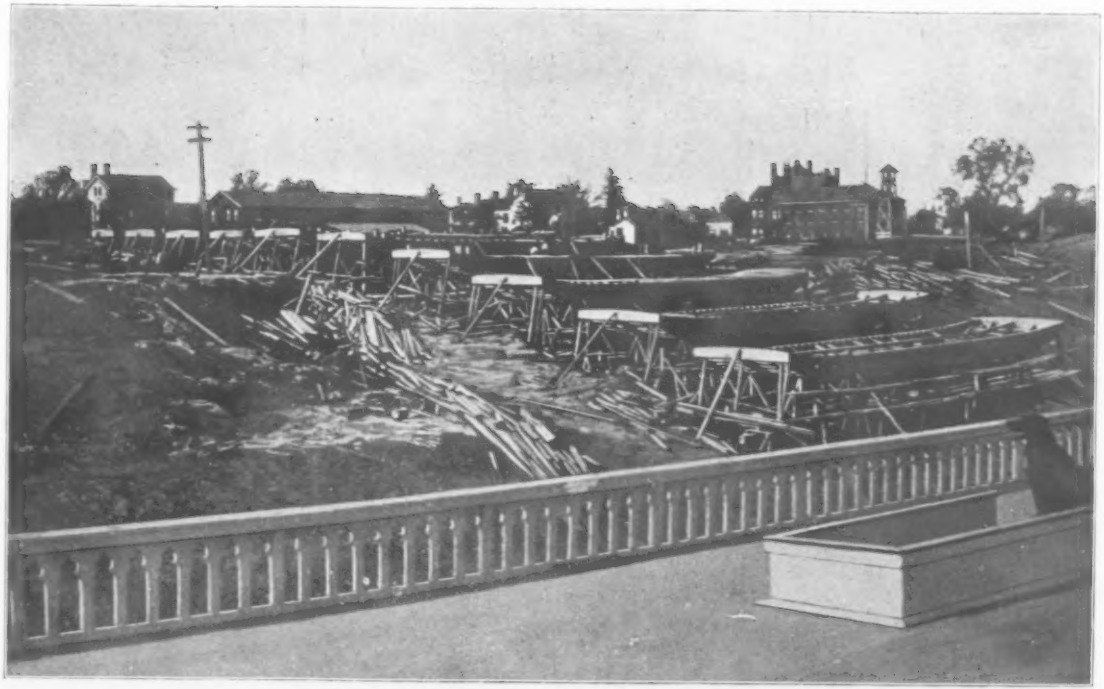
the *Eclipse*. She had ten boilers, 34 feet in length and 42 inches in diameter; her engines had a diameter of 43 inches and a stroke of 11 feet, while her water-wheels were 44 feet in diameter and her buckets 19 feet. She could accommodate 250 passengers with state-rooms, and carry 10,000 bales of cotton. The cost of this handsome boat was $200,000.

As showing the difference between the river trade before the war and now, it is pertinent to say that formerly there was a daily line from Memphis to New Orleans, where now there is none; that



INTERIOR OF CABIN ON A STERN-WHEEL STEAMBOAT.

the daily line to Cincinnati has dwindled to a semi-weekly; that the tri-weekly line to St. Louis has become a once-a-week affair; that the tri-weekly to Vicksburg and White river has been abandoned; that the boats which formerly made two trips a week up the St. Francis river now make one; and that the weekly trips to Obion river and up the Hatchie have been discontinued. Captain James Lee, the president of the Lee line of steamers, informed the writer that during his connection with steamboating freight rates had been reduced from $1 to 25 and 40 cents a barrel, that cotton



UNITED STATES GOVERNMENT FLATS FOR IMPROVING THE MISSOURI RIVER.

[This view, taken from the deck of a steamboat, shows ten of thirty-four flats, building at Howard's Shipyard, Jeffersonville, Ind.]

freights had dropped from $2 to 40 and 50 cents, and that there was now only about one-third of the river business that had been done formerly. The Lees were the first to inaugurate the short line system of three trips a week, a system which concentrates everything at a given point.

In the last ten years Memphis has become the second cotton market in the United States, and it may not be uninteresting to see just how far the railroads have affected the shipments of cotton to and from this point by river. These figures, for twenty-three years past, show that receipts and shipments have fluctuated considerably, but that the river has held its own in spite of the competition of the railroads and other influences. This is probably due to the fact that the cotton crop has increased about three-fold during this period, but the figures are important as proof that the river traffic cannot be done away with, and that it has a normal volume which may be expected to endure. For the season of 1870-71 the river receipts were 204,933 bales and the shipments 280,500. For the next three seasons the receipts averaged about 135,000 bales and the shipments about 140,000. For the season of 1874-75 the receipts as well as the shipments dropped below 100,000 bales. The following season the receipts ran up to 142,244 bales, and the shipments to 157,000. During the next ten years receipts fell off pretty steadily, until in 1884-85 they were only 90,000. During this time the shipments were in excess of the receipts, but from 1885 the shipments rapidly fell off, dropping from 123,825 in that year to 27,979 in 1891-92. But from 1885 to 1891 the receipts were as large as during any similar period in the cotton trade of the city, the average being about 140,000 bales. A variety of exceptional influences in the last two years has affected the trade, and so the river men handled in the season of '92-93 only some 76,000 bales all told. It looks very much as if the shipments by river from this port were virtually a thing of the past. No cotton is now sent south from Memphis by river; such as is shipped goes north. Of course boats will continue to bring cotton to Memphis and take it to other markets, and this line of traffic will hardly be affected by any change of conditions that can be conceived of.

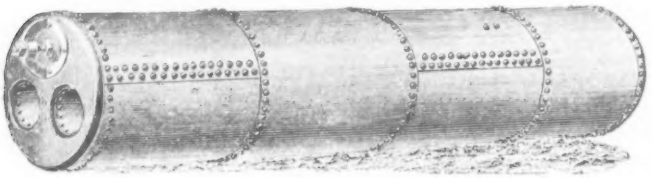
While the tendency in steamboat-building in later years has been in the direction of cheapness and compactness, there is one line of boats that may stand comparison with the gorgeous palaces of which the old river-men love to speak. This is the famous Anchor line, of St. Louis. It is said by those competent to judge

STEAMER "ENRIQUE," MAGDALENA RIVER, BUILT AT PITTSBURGH, PA.

that the *City of Hickman* is as fine a boat as any of the old-time runners. It is not as elaborately decorated, perhaps, and not so richly furnished, but it embodies many improvements which were denied the boats of an earlier day. This steamer cost about $125,000, and for this sum there can be little doubt that a boat can be built to-day which would compare very favorably with the *White*, the *Lee*, or the *Pargoud*. The Anchor line maintains a number of boats of virtually the same type. The superb engines of these vessels could not be surpassed, and their hulls are as sound as it is possible to make them. They were built for the most part by the Howards, of Jeffersonville, on the Ohio. Their cabins are neat and spacious, but it is doubtful whether they are as elegantly fitted up as the famous boats of the past. These boats are about 300 feet in length, and they carry from 1200 to 2200 tons freight. They are named after different cities, and when one wishes to find some likeness to the splendid boats of river history, he can come very near it by examining the *City of New Orleans*, the *City of Hickman*, the *City of St. Louis*, or the *City of Cairo*.

In recent years a new arrival has made its appearance in the river business, which is the steel boat. It is the opinion of the most intelligent river-men that this kind of boat will eventually supersede all others. The pioneers in this kind of boat-building were James Rees & Sons, of Pittsburgh. This firm built some of the most beautiful boats ever used on the Mississippi, but about fifteen years ago they turned their attention to the construction of steel hulls for boats, and they have thus given an impulse to an entire revolution in the business. The steamer *Francisco Montoya*, the first steel hull steamboat ever constructed in the United States, was built at Pittsburgh in 1878 by James Rees, of the Duquesne engine works, for the South American trade. The hull was 140 feet long, 28 feet beam, four feet hold; cylinder 15 inches diameter of the cylinder, with 5-foot stroke. A guarantee was given by the builder that the boat would run twelve miles an hour and carry 75 tons of freight in two feet of water. The boat was a great success, and is to-day running on the Magdalena river in Colombia. The first steel-hull steamboat built to run on the inland waters of the United States was the steamboat *Chattahoochee*, constructed by the same Pittsburgh firm in 1882. The hull was 155 feet long, 31 feet beam, 4½ feet hold; cylinder 15 inches diameter, with a 5-foot stroke. This boat was built for the People's Steamboat Company, of Columbus, Georgia.

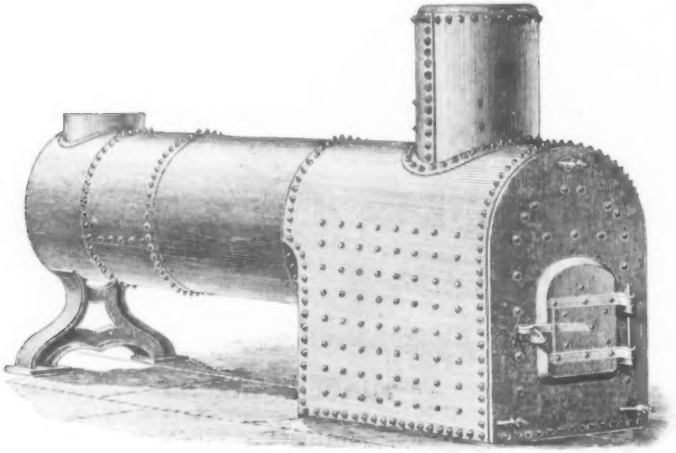
FLEET OF STEAMBOATS ON THE MAGDALENA RIVER, COLOMBIA, SOUTH AMERICA,
Built by James Rees & Sons, Pittsburgh, Pennsylvania, U. S. A.



STYLE OF BOILER COMMONLY USED ON STEAMBOATS.

Since January 1, 1880, the firm of James Rees & Sons have constructed twenty-three steel-hull steamboats for rivers in Nicaragua, and for the rivers Zulia, in Venezuela, and Magdalena, in Colombia. These are all typical light-draft river steamboats, having every facility for handling freight and passengers. The boats are all set up complete in the yards at Pittsburgh, then taken apart and shipped by rail to New York city, thence by vessel to South America. The cost of a steel hull is about three times that of a wooden hull of the same dimensions. The steel-hull boat will draw light, about one fifth less than the wooden hull of the same dimensions. The advantages of the steel hull in the way of permanence and safety need hardly be pointed out.

Howard's ship-yard at Jeffersonville, Indiana, is the largest in the United States under the exclusive control of one person. It



STYLE OF BOILER SOMETIMES USED ON RIVER STEAMERS, FOR COAL OR WOOD.

was established over forty years ago by Captain James Howard, and is now owned and controlled by Captain Ed. J. Howard, one of the best marine architects and builders in the country. It has turned out some 555 vessels of every description, some of them being the largest and finest on the Western waters. According to Captain Howard, the character of the work has changed very much in the last ten or fifteen years, the fine and fast palatial steamers of former times having been succeeded by small stern-wheel boats and barge lines. Captain Howard states that he is probably doing the same amount of work as formerly, but it is of the latter character; he never has a call now for a *White*, a *Robert E. Lee*, or a *John W. Cannon*. He says in a letter to the writer, that, while steamboating is at a low ebb, "as long as the rivers of the west and south flow down stream, they will command a portion of the commerce of the great valley. Freight can now be carried cheaper by river than by rail, and if the items of expense—viz.: fuel and labor—could be reduced to a minimum, freight-rates could be reduced still lower, but it is only the local business along the banks or the through bulk grain trade to foreign ports that the river can legitimately hold."

The United States government is making every effort to improve the navigation, getting better depth of water during the summer season. The Howard yard is now building an experimental dredge-boat for the government to be operated on the Mississippi river between St. Louis and Cairo. If it proves a success in getting a better depth of water, it will have accomplished much for the river interests. What effect electricity may have in the river navigation of the future is, of course, problematical; but it would not be surprising if, in this field as in almost every other, there should be a revolution.

There is now being built for the Lucas Navigation Company a steel boat which will ply between St. Louis and South America. This is in the nature of an experiment. If more intimate commercial relations are established between South America and the United States, it is possible that a very handsome trade will spring up between the Mississippi valley and our neighbors of the far South. It has been a dream of many people of this valley that some day would see ocean steamers in the ports of Vicksburg, Memphis, Cairo, and St. Louis. During the bridge celebration at Memphis last year the United States gunboat *Concord* not only went with ease as far north as Memphis, but it also reached Cairo,

when it was recalled. There was formerly a navy-yard at Memphis, the value of which was not appreciated, and in later years there has been much talk of reëstablishing it. One of the chief arguments advanced for so doing is that in case of war an inland navy-yard is much better protected from foreign attack and reprisal than one on the coast. Whether this is ever done or not, there can be no good reason why the Mississippi valley should not maintain a direct connection with the sea, or why in the not distant future the river trade should not resume some of its old-time activity. Of course this activity will be exerted under new conditions.

The old time river life can hardly be duplicated to-day. It was absolutely unique. The big steamer was formerly a sort of floating improvised town. Some of the boats even had their newspapers, and gambling flourished without the slightest hindrance. Over forty years ago a newspaper was published on the steamer *James W. Woodruff*, edited by Captain C. S. Rogers, then clerk of the boat. The composing room was located beneath the ladies' cabin, and was in the charge of a single compositor. It contained personals about those who were on the boat, news picked up at the different landings, record of the distance run by the boat the day previous, and such news. These little papers were filled with the advertisements of those who sold the boat anything in the way of provisions, light, or fuel. They were sold in the morning to the passengers, who often paid as much as 25 cents for a copy. James Kerr, Jr., now of New Orleans, edited a paper on the Red-river steamer, the *Grand Era;* and Will L. Visscher, now of the State of Washington, won some journalistic laurels, as well as shekels, in this kind of work. There was also a paper called the *Richmond Headlight*, published on the steamer *Richmond*, plying between Cincinnati and New Orleans, edited by Robert R. Rea, now of Madison, Indiana. Features like this will probably have to be left out of the prospective revival of the river business.

Steamers like the *White*, the *Lee*, and the *Natchez*, would probably be run at a loss to day on account of the railroad competition and the low land freights. Thus the steamboat of the future will offer a sort of compromise between beauty and speed. The reduction in freights was inevitable. Some old steamboat captains fondly refer to the time when they got $50 for carrying a bale of cotton, and there was a time when it cost $4 to carry 100 pounds of freight from Nashville to New Orleans. Such rates were absurd

and inequitable, and of course they have been scaled down by the conditions of to-day's traffic. On the Ohio, it is reported that the river interests are looking up, and that the Cincinnati lines to Memphis and New Orleans on the one hand, and the lines to Louisville and Pittsburgh on the other, have pretty much all the freight they can handle. If the Ohio had deep water all the year round, the trade would be largely enhanced. From 1850 to 1861 Memphis shipped annually to New Orleans 300,000 bales of cotton by boat, and 100,000 more were picked up on the Arkansas and Mississippi coast. Now Memphis does not ship south at all. This, however, is not due entirely to the decadence of the river, but, as already pointed out, to the fact that Memphis has become a great cotton market, second only in importance and magnitude to New Orleans; and a vast amount of the staple that formerly found its way to that city now finds its way to Memphis.

Perhaps the greatest factor in keeping back the river traffic on the Mississippi has been the overflow. For four years past the lower lands have been under water once a year. These overflows have either destroyed a large amount of crops already planted, or have postponed the planting until it was too late to raise a good crop. Public and financial distrust is born of the overflow, and the shipping business is paralyzed. Indeed business in every branch suffers. Similar conditions prevail on the Missouri river. The daily line between St. Louis and St. Joseph and Omaha is now a once-a-week affair, and even that is poorly supported.

Two years of freedom from overflow, coupled with some efficient method of protecting the river banks, would probably quadruple the river business on the Mississippi. The opening of the coal-fields in Kentucky and Alabama has been of advantage to the river, and has also been a good thing for the consumer. Pittsburgh coal was formerly sold at from 60 to 90 cents per bushel along the Mississippi; now it is from 32 to 35 cents, while Alabama and Kentucky coal can be had for 25 or 30 cents. This reduction is due to competition and to the river. That the revival of the river business is probable cannot be controverted by any keen observer; and under improved conditions a revolution is possible.

THE GROWTH OF COMMERCE ON THE LAKES.

By H. C. Pearson.

THE growth of our commerce on the lakes, even during the life of one man, is simply marvelous, utterly transcending the dreams of fiction. The details of its history read like fairy tales; but in a magazine article it is impossible to give more than an outline of the most remarkable development of marine traffic the world has ever known.

In the winter of 1833–34 Augustus Pickering, of Sackett's Harbor, New York, built what was then called a large vessel,—a schooner with dimensions thus stated by George L. Dickinson (now of Muskegon, Michigan), who was one of the carpenters who helped to build it: This vessel was as large as could be got through the wooden locks of the Welland canal, its length being 80 feet, breadth 20 feet, and depth of hold 8 feet. It was called the *Illinois*, and it sailed on May 12, 1834, with 104 passengers, for the village of Chicago. Mr. Dickinson and his young wife were among the passengers. The cargo consisted of the household goods and farming implements of the passengers, bound "for the far west," who availed themselves of this means of transit as the most convenient at the time,—railroads being unknown, and steam vessels hardly out of their swaddling clothes.

After calling at numerous places for resting the passengers and replenishing the stock of "sea-stores," the *Illinois* arrived off the mouth of the Chicago river (creek) about June 14, but it could neither land nor enter the "harbor," for there was no harbor, but instead a formidable bar across the mouth of the creek. There being no docks in what was called the harbor, no lights, no tugs, no anything but mud,—mud in the streets and out of the streets,—the passengers and light goods were put ashore by means of the ship's yawl, the heavier goods going by raft as the weather would admit. The only hotel being full, our passengers housed themselves as best they could, some finding shelter in a two-room log-cabin called a tavern, on the west side, though Captain Pickering succeeded, a short time after, in securing a small house of Mr. McKinzie, a government Indian agent.

After the cargo of the little schooner had been discharged, the

people of the village told Captain Pickering that, as he had been gallant enough to name his vessel after their State, they wished to acknowledge the compliment in some fitting manner, and proposed to take his schooner over the bar (which carried but four feet of water), if such a thing were practicable; so that it might be said that a vessel had actually been in their harbor. After due consultation the idea was decided to be feasible. Accordingly anchors were carried out, a purchase rove to the windlass, and with much vigorous shouting, rolling of the schooner's booms, and heaving at the windlass, the thing was done, and the little schooner *Illinois* floated proudly in the port of Chicago,—the first vessel that ever graced that harbor.

But what a change in fifty-nine years! Then, as now, immense trains came into Chicago, but of different construction from those of the present day. Their motive power consisted of three to five yokes of oxen, and the cars were of the four-wheeled type instead of the modern "Pullman," covered with white duck, and called "prairie schooners." And now, from a hamlet of a dozen houses in 1832,—the place being organized as a village in 1833, and receiving the first vessel into her harbor in 1834,—her population is grown to more than 1,000,000.*

Besides gaining an enormous commerce, she has an immense iron-rolling and shipbuilding plant, has become the greatest primary grain market in the world, the greatest lumber market in the world, and the greatest meat-shipping center; and now she has at her doors the world's greatest industrial exposition.

Another marvel of growth, though on a smaller scale, is seen in the little town of Escanaba, an iron-ore center, in the northern part of Green Bay.

From the *Marine Record* (Cleveland) of February 12, 1893, are gathered the following facts: "In 1889, Bilboa, in Spain, with a population of 50,000, shipped 3,000,000 tons, while Escanaba shipped during the seven months shipping season of the same year 3,800,000 tons, the population being only 8000. So this little city, nestling under the pines of northern Michigan, sparkling with her electric light, cooling herself under her self-planted shade, besides her annual output of 200,000,000 feet of lumber, claims to be the largest iron port in the world."

* The Chicago City Directory for 1893–94 contains about 500,000 names, which, if the usual ratio of total population to names in city directories obtains in Chicago, would indicate a remarkable growth since the last census, and that the population is now not far from 2,000,000.

The unprecedented and rapid growth of commerce on Lake Michigan, as seen in the marvelous growth of Chicago, Milwaukee, and Escanaba, is being repeated on Lake Superior. The germs of commerce on that lake are seen in the birch-bark canoes of the early Jesuit Fathers, in the latter part of the seventeenth century, winding their way along the coast on their exploring and missionary voyages, planting missionary stations at Marquette, Copper Harbor, Lapoint, and elsewhere. In 1680 Captain John Duluth visited the head of the lake, and soon after his brother built a trading-house on Minnesota Point.

The enterprise of these early pioneers was followed in 1803 by some hunters and trappers with a few small schooners engaged in the fur trade. In 1810 to 1812 two other schooners made their appearance on these waters. But Lake Superior, having no navigable inlet or outlet, though lying in the direct line of what was soon to be the great highway of a transcontinental commerce, could do nothing more than to employ a few of these small craft in the coasting trade. A change was near at hand. The prospect of the forthcoming North Pacific railroad, together with the favorable outlook for a canal and locks by the Sault Ste. Marie rapids, and the discovery of immense deposits of iron about the shores of the lake, stimulated enterprise. "In 1845, the propeller *Independence* was hauled overland at the 'Soo,' and successfully launched on the waters of Lake Superior. In the autumn of 1846 the *Julia Palmer* was also taken over and launched on that unsailed sea. And in the same season the little schooner *Uncle Tom* was run down the 'Soo' rapids because there were too many vessels on Lake Superior to pay." *

In 1855 the canal and lock at the "Soo" were opened to traffic, and the commerce of Superior was connected with that of the other lakes. This event had a marvelous effect in stimulating the growth of commerce on Lake Superior. The movement of ore, lumber, coal, grain, timber, flour, mining-machinery, milling-machinery, and every species of merchandise known to be required by people of a new country, began as if from spontaneous animation. And the fact was immediately developed that this canal and lock were not large enough,—that their capacity, though they had cost $3,000,000, would be speedily outgrown.

The necessity of increased capacity became so obvious that in

* E. Ward in *Marine Record*, April 20, 1893.

1870 the present lock, with the corresponding enlargement of the canal, was ordered by the United States government at a cost of $2,250,000. The cells of this lock are 515′x80′x16′5″ having about three times the capacity of the original lock; and yet this magnificent work—the finest single structure of the kind in the world—was soon seen to be inadequate to the demands to be made on it in the near future. Accordingly, still another lock, 800′x100′x22′ 2″, or double the capacity of the present one, was determined upon, and it is now in process of construction at an estimated cost of $5,000,000. The new lock is to be parallel with the present one, the pit occupying the site of the original lock. This improvement, of course, involves the widening and the deepening of the Sault Ste. Marie canal, throughout its entire length of 7000 feet.

The accuracy of observation by the officers of the canal concerning the growth of commerce to be provided for was amply vindicated by the amount of traffic for the year 1890, which was 9,041,213 tons, valued at $102,214,948;—lacking but a small amount of being double the commerce of 1885, and being 1,500,000 tons greater than for the preceding year.*

The Canadians, seeing the phenomenal growth of the Lake Superior commerce while yet but in its incipient stage, commenced the building of a canal and lock by the "Soo" rapids, of nearly the capacity of our new lock, and they have the work now well in hand.

Duluth, being at the head of navigation, occupies a position with regard to Lake Superior traffic analogous to that of Chicago on Lake Michigan; she must make provision for an immense transfer of tonnage. A glance at the newspapers will show what is being done there to meet the demands for the growth of commerce. "The Saginaw Lumber Company are doubling their dock room at their big mill at West Duluth, and will soon have 1½ miles of dock-front on two half-mile slips. This, with the Mitchel & McClure docks, will make three miles of dock-front, on four adjoining 2600-foot lots, affording dock room for 50,000,000 feet of lumber. The Duluth, Missabe and Northern railway will arrange for the building of another mammoth ore-dock shortly, close beside that now under way. It will be 2350 feet in length, and, with the exception of the present dock, will be the largest in the world. No

* See Report of General O. M. Poe, United States Army, in *Marine Record*, December 11, 1890.

similar area in the lumber world on the lake or elsewhere can produce such a collection of docks as these."*

The magnitude and depth of the new locks involved other and enormous outlays to make these improvements available. The Sault Ste. Marie canal must be again widened and deepened, as also must the Ste. Marie river, and the Detroit river, in many places; and a new channel through Hay lake was determined upon for the double purpose of shortening the route about eleven miles and bringing the improvement entirely within the territory of the United States. In this work, excepting the lock, is entailed the largest expense of all, estimated at $2,500,000 to $3,000,000.

A consideration of the immense flow of the transcontinental commerce to come from the inexhaustible resources of the northwestern States as developed by the Northern Pacific railroad, together with the vast amount yet to come from Manitoba, the valley of the Sascatchewan, and the Red river of the north, and the measureless volume of ore to come from the newly discovered mines in northern Minnesota, has been the chief factor in determining on the enormous outlay for the improvements above mentioned.

Before one can fully comprehend the magnitude of some of this work, it must be seen. The mind can comprehend the relation of numbers, but can gain no idea of magnitude without the help of the eyes. Thus, the new lock-pit involved the excavation of about 1,000,000 cubic feet of earth and rock. Now this line of figures gives us no idea of the volume, for 1,000,000 in the abstract is utterly beyond our grasp. But going on the ground, we see the volume developed under its proper lineal units, and, when we can thus "take it in," get the idea of an elongated crater of a volcano rather than of artificial work.

The appliances for carrying on the work are on the same magnificent scale. In the pit above mentioned we will see a number of traveling or locomotive cranes, working on a truly "broad gage" of sixteen feet. These cranes take up a stone anywhere in the pit, and lay it down at any point within forty feet of the center of the tracks, the stones ranging from one ton to four or five tons each, or possibly more. The student of engineering will see numerous appliances for carrying on the work, which necessity, the prolific mother of invention, has devised. Among these will be found a machine for planing stone, precisely as we see a piece of iron

* *Marine Record*, April 6, 1893.

planed in a machine-shop. Another notable machine is one for stopping the leaks that may occur under a coffer-dam, as in a fault of the rock, or between the timbers or cribs, and the bottom of the cut. This is a most important appliance. It consists of a well-boring auger, for sinking a well-tube, say four inches in diameter, through earth or rock to the leak. Then this tube is filled with cylinders of clay, which are driven down with a follower under the hammer of a pile-driver, ejecting the clay from the foot of the tube with tremendous force, even to the bursting of the embankment, or lifting the dam.

The ice-boring machine is another device produced under the stimulus of Dame Necessity. With this machine two men can do the work of twelve to fourteen ice-choppers,—thus enabling Mr. Ripley, with a gang of men, to make over 60,000 soundings from the surface of ice for the purpose of determining the amount of excavation requisite for the new channel. Another machine is used on the same work for making the excavation in rock. This machine, being located precisely in line where wanted, by means of two transit instruments or otherwise, is firmly anchored by means of spud-anchors. It then drills holes to the depth of twenty-one feet,—three at a time, five feet apart each way,—drops ten pounds of dynamite in each hole, and fires the same, without moving, the bottom of this "drill scow" being made strong enough to stand the concussion of the shock twenty feet below. In this manner the channel is broken up 1300 feet wide, and the dredges follow, cleaning out to twenty-one feet deep in rock cutting and twenty feet in earth-work.

Then follows the "floating gage" for proving the depth of the work. I cannot do better than give the words of Professor J. B. Davis, of Ann Arbor, concerning this appliance. Referring to Mr. Ripley, in charge of the work, he says: "He has a float 120 feet in length, with a hole in the middle of it 100 feet long. Over the hole is a system of windlasses. From these, chains are suspended, connecting to iron bars. By means of instruments planted on the shore, he will locate the float at any desired point in the channel. Then, by means of a tug-boat or otherwise, he will move the scow (float) across the channel. The irons, being suspended from the chains, sunk to a depth of twenty-one feet, will sweep the bottom of the channel completely, over 100 feet of its length. There are men standing with their hands on every chain, and the instant the bars touch bottom it is known. The scow is stopped, the sounding

rod is set on that spot, the men on shore locate it by means of their transits, and they find that stone if it isn't a couple of inches in size."

A little vessel of sixty tons, called the *Griffin*, was the first to spread sail on any of the western lakes. This vessel was built at the mouth of a small creek some six miles above Niagara Falls by La Salle, in 1679, and armed with seven small cannon, two of which were of brass. It was with much difficulty that it was towed up the Niagara river against the current. But finally, on August 7, a fair wind, supplemented with the efforts of a dozen men on a towline, brought the vessel into Lake Erie. She went to Green Bay, Lake Michigan, on a trading tour, and from this place she was sent back with a cargo of furs, a pilot, and five men, by La Salle, on September 10, but was never heard from after.

The *Walk in-the-Water*, the first steamer to vex the waters of Lake Erie, was launched at Black Rock on May 28, 1818. As with the *Griffin*, much difficulty was met in getting her up against the swift current of the river. The strength of the engine was supplemented finally with oxen. She made her first trip to Detroit in the August following. Thus the *Griffin* and the *Walk-in-the-Water* were the pioneers of an immense commerce.

In June of 1795 La Rochefoucauld Laincourt visited this place, —called Buffalo by some, New Amsterdam by others. He speaks of an inn where he was obliged to sleep on the floor in his clothes, and in which there was neither rum, candles, nor milk.* Now the city of Buffalo claims a population of 300,000, and, after Chicago, she is the first commercial city of the lakes. The greatness of her commerce can best be seen by looking at some of her facilities for handling various materials and products. The new coal pockets of the Delaware, Lackawanna and Western railroad, of about one mile in length with a capacity of 100,000 tons storage, are but one of her many plants for handling coal. But it is in the handling of grain cargoes that her superiority over every other city in the world is seen. Prior to 1843, all transfers of cargoes were made by hand power, or horse power, the cargo being lifted in bags or tubs. But now Buffalo has thirty-two elevators, with a capacity of 13,000,000 bushels ; ten transfers, and six floaters, or forty-eight in all, with a total capacity of 13,080,000 bushels storage, and a transfer capacity of 4,000,000 bushels per day.

The facilities for handling cargoes of coal and ores at Cleve-

* "Buffalo Annual," by John Lauchlin, for 1893.

land, and indeed in all lake-ports where these materials are moved, are on the same magnificent scale. This facility for the handling of cargoes on the lakes is the marvel of most people from abroad. It is no uncommon thing for a vessel carrying 3000 tons of ore to be loaded in from four to five hours, and with grain the despatch is even greater. But the greatest marvel to be seen on the great lakes is the wonderful stream of commerce traversing the river between Lake Huron and Lake Erie. Frequent countings by the marine reporters on the river at Port Huron indicate in round numbers 80,000 passages during the navigation season,—usually about 240 days. General O. M. Poe, in charge of the work at the "Soo" canal, reported the number of vessels of all kinds passing the locks in 1890 to be 10,557, with a total measurement of 8,454,435 tons, giving a fraction over 800 tons measurement for each vessel of every kind,—including yachts, tugs, and lighters,—and a fraction over 856 tons of freight carried for each individual passage, the total freight carried being 9,041,213 tons. At this rate we should see passing a single point thirteen or fourteen vessels per hour, during the whole season, each with an average cargo of 856 tons. At no other place in the world can such a stream of commerce be seen. Yet it is so little known abroad that in the Lloyd's (London) comprehensive tables of foreign and colonial shipbuilding for 1892 the work on the great lakes is completely ignored.

THE NEED OF UNIFORM BUILDING LAWS.

By William J. Fryer.

THERE is a growing demand for greater uniformity, as between different States and cities, in laws bearing upon social and business or professional relations. Uniformity in divorce laws, for instance, has been strongly urged. Uniformity in laws regulating the transfers and registration of real estate has also been demanded, in order that a citizen of one State may be able to buy and sell in any other State as readily as in his own. Of all the subjects of legislation there is none in connection with which uniformity is more to be desired than that of regulating the construction of buildings. Yet uniformity in laws bearing upon affairs over which individual States have exclusive control—as is the case in America—can only be hoped for through the efforts of individuals or associations acting within the territorial lines of a State. The desired object is more readily obtainable, however, after some one State, by force of example, has cleared the way for other States to follow.

The progress made recently in the enactment of building laws, particularly in the Western States, has been due largely to the fire engineers. The chiefs of municipal fire departments have a powerful national association, and the members, when attending their annual conventions, hear much about methods of preventing as well as extinguishing fires, of fire-escapes for buildings, of slow-burning construction, of defective construction, of limitations to heights and areas of buildings, and of desirable regulations that exist in one city and not in others. They go home determined upon getting building ordinances for their respective cities, embracing the latest and most improved ideas. As the fire chief is an important and influential man in his own city, he can usually succeed when he tries to get any new regulation adopted.

A few years ago the firemen's association published a pamphlet containing suggestions for a model building ordinance. A joint committee from the American Institute of Architects, the National Association of Builders, the National Board of Fire Underwriters, and the National Association of Fire Engineers was appointed to prepare a model building law, but it has done practically nothing.

The fire underwriters are providing a universal schedule for rating risks from fire in buildings by laying down conditions which will constitute a standard building, supposed to include all approved methods of construction and arrangement, the intended effect being to induce owners, from self-interest in obtaining low rates of insurance, to build safer than they otherwise would in cities where there are no building laws.

One of the recognized methods of public protection of life and property is by building laws. A man has no natural rights in land and buildings. It is statutory law that secures the weak and strong alike in their peaceful holdings of property, which in the eyes of the law is theirs. Order and safety are maintained through forms of government established by the people themselves. It is their privilege to aid in securing the passage of wise laws and to obtain the repeal of bad ones, but it is also their duty to faithfully obey every law on the statute-books. It is to the credit of architects generally that they honestly comply with building laws, and their mistakes of non-compliance are unintentional, as a rule.

A perfect building law has not yet been drafted, and it is safe to say that it never will be. The building laws of London, Liverpool, Paris, Berlin, and other great foreign cities are poor models for American cities to follow, and upon investigation will be found to compare unfavorably with American laws, insufficient and faulty though the latter may generally be both from a legal standpoint and that of the builder. Building laws, like all other kinds of laws, will advance with the increase in intelligence and the general progress of the times. As new methods of construction come in vogue the law must take cognizance of them, and, as in the case of the modern skeleton construction, meet new conditions by providing reasonable safeguards. When a building is to be erected which is to tower above the limit of a fire department to successfully cope with fire, the whole community has a direct interest in demanding that it be so built as not to burn, or to topple over in a gale of wind. The humblest building, too, is rightly a subject for public solicitude. In a frame shanty the overturning of a lamp by the kick of a vicious cow started a conflagration that inflicted a loss of more than a hundred millions of dollars upon the citizens of Chicago, and, through the distributing medium of insurance, upon the whole of the United States.

For many years the laws of two States—New York and Massachusetts—have been principally taken as guides by law-makers

in other States, and of the two, in more recent years, the laws of New York have been most in favor. When a legislator in a southern or western State desires to draft a law, he turns to the volumes containing the session laws of the State of New York, with almost a certainty of finding in them what he wants. Doubtless if the State of New York would enact a code of uniform building laws for her own cities, the other States would soon after adopt the same or similar laws. The need of suitable building laws for cities of moderate size has been long acknowledged, and is becoming greater every year, as such cities increase in population. Other States are as badly off as New York. Under legislative act Governor Flower of New York in 1892 appointed a Commission to draft and report uniform building laws in three classes applicable to the various cities of the State, excepting the cities of New York and Brooklyn. The task was a difficult and arduous one, requiring months of active and thoughtful attention. The charter of each city in the State had to be examined, together with the ordinances enacted thereunder relating to buildings. A copy of the building laws of every city in the United States known to have such a law was obtained and carefully studied, for, while the main idea of the Commission was to grade down the New York city laws, it was proposed to adopt good features found in the laws of other centers of population.

The New York city law formed the natural basis of this work, since it is the result of nearly fifteen years' continuous labor by competent and experienced men, and its comprehensiveness is, therefore, not to be wondered at. The betterment of that law was first taken in hand by individuals and commercial organizations, because their business interests compelled them to take some action, and circumstances so shaped themselves as to necessitate continuous and unremitting work. Architects, builders, fire underwriters, fire engineers, and lawyers have taken part in its several revisions. It is the united work of not less than fifty men, and from first to last perhaps the number has been closer to a hundred, numbering some of the ablest men in the various trades and professions represented.

Taking the New York city building law as a basis, the Commission scaled down its requirements, and in due time submitted to the State legislature three grades of proposed building laws for other cities. Chiefly for political reasons these laws failed to be enacted, though Governor Flower was known to be in

hearty sympathy with the movement. At the next session of the legislature, however, they will again come up for consideration. In the opinion of the writer their acceptance and passage will be of the greatest benefit to the safety of human life throughout New York State, and, by their influence, throughout the whole country. Including the New York city laws, there have been proposed four uniform grades of building laws, applicable to cities from the largest size down to a population of 10,000.

About forty cities in the United States already have building laws, some of them of local adoption by the common council, and some of them enacted by the State legislature, when that power is not vested in the cities by their charters. A few of the older cities have had building laws for the past twenty-five years or longer, but even these cities have, for the most part, secured new laws or had their old ones amended to such an extent as to make them practically new. The following list gives the names of the principal cities having building laws and the dates at which the regulations now in force were adopted:

1893—Chicago, Ill.; Hartford, Conn.; Philadelphia, Pa.

1892—Boston, Mass.; Buffalo, N. Y.; New Orleans, La.; New York city; Providence, R. I.

1891—Albany, N. Y.; Baltimore, Md.; Indianapolis, Ind.; Minneapolis, Minn.; Syracuse, N. Y.; Washington, D. C.

1890—Butte, Mont.; Cleveland, O.; Detroit, Mich.; Kansas City, Mo.; Louisville, Ky.; Memphis, Tenn.; Milwaukee, Wis.; Sioux Falls, S. D.

1889—Denver, Col.; Seattle, Wash.; Tacoma, Wash.; Worcester, Mass.; Yonkers, N. Y.

1888—Brooklyn, N. Y.; Lynn, Mass.; Pittsburgh, Pa.

1887—Cincinnati, O.; Nashville, Tenn.; St. Louis, Mo.

1886—Wilmington, Del.

1877—Newark, N. J.

San Francisco, Cal., has an old law, but a new one is in course of preparation, it is stated. Newark, N. J., is preparing a new law. A new law for Brooklyn was recently hurriedly prepared by a Commission appointed by Mayor Boody, but awaits action by the next legislature. Several cities, including Charleston, S. C., have building ordinances scarely worth mentioning as such. Many of the laws are feeble imitations of an old Boston law, but more of them are, to a considerable extent, copied after an old New York law. A certain sort of broad uniformity runs through the whole lot.

The clothing of ideas in suitable language is a difficult matter in drafting building laws. Architects, builders, insurance men, and firemen have not the lingo of lawyers at their tongues' ends, nor do lawyers always readily grasp the meaning and force of building terms. One sentence in a law must not conflict with another sentence; one paragraph must not repeat something already stated in another paragraph, although mere repetition is of no serious consequence; nor must one section permit that which is prohibited in another section; and omissions must be looked out for as well. Annoying discrepancies and provoking mistakes are pretty sure to rise, sooner or later, to the chagrin of the compiler of the law. In the building law of New York city there is a requirement that every building hereafter erected to be used as a hotel, exceeding a stated height, must be fireproof, and every building hereafter altered to be occupied as a hotel must have the first floor constructed fireproof. The point has been raised and held to be well taken that a building already occupied as a hotel can be raised and otherwise altered without having to put in a fireproof floor on the first story. Although the framers of the law intended that new hotel buildings should be built entirely fireproof, and buildings altered to be occupied as hotels should be partly fireproof, they made no reference to buildings already occupied as hotels. Notwithstanding the revision committee's intent as to buildings altered from other uses to be occupied as hotels, a court recently decided that, by reason of another section in the law, which declares that no building already erected shall be altered in such a manner that, were such building wholly built or constructed after the passage of the law, it would be in violation of any of its provisions, therefore a building could not be altered for hotel uses unless the building was made entirely fireproof. An appeal to a higher court may secure a different interpretation of the meaning of these sections.

Trade prejudices frequently crop out in a committee engaged in preparing a building law. In Brooklyn's proposed law the selection for the chief officer for the Department of Buildings was at first to be confined to a "practical mason or carpenter." After some little discussion and persuasive argument an architect was added, so that the wording became "a practical mason or carpenter or architect,"—the architect being last in the order of their honorable mention. "Practical" persons will probably think the addition of an architect to the eligible list no great advantage in securing efficiency for the public service. Mention of this Brooklyn episode

is made here simply to record a fact and not to exalt architects in general or "practical architects" in particular.

The New York city building law contains a unique provision in the way of a board of examiners made up of representatives from several trade associations. This board has power to vary the law in cases where it is claimed by an owner that the law does not directly apply or that an equally good or more desirable form of construction can be employed than that required by the law, so that the spirit of the law may be observed, the public safety secured, and substantial justice done. In the proposed New York State laws the superintendent of buildings is given full power to vary or modify the provisions of the law where there are practical difficulties in the way of carrying out the strict letter of the law, but, when the superintendent refuses to issue a permit, an appeal may be made by an applicant to three disinterested and competent persons, one to be appointed by the superintendent, a second by the applicant, and the two so chosen to select the third, and the decision of the board to be final and conclusive. The applicant is required to deposit with the superintendent thirty dollars when the appeal is made, and this money is paid out to the members of the board of appeal, ten dollars to each. Boston's law provides for a continuous board of appeal. St. Louis is considering the advisability of adopting the New York system, which is not by any means to be recommended.

The building laws of several other cities provide for appeals from the decision of the superintendent, but most of the laws contain no appeal clause. The right to appeal is an important one, and should be inserted in every building law. Superintendents are apt to develop human weaknesses and become dictatorial and arbitrary, and to forget that they are the servants and not the masters of the people. It is greatly to the interest of all concerned to have a building law comprehensive and clear, leaving as little as possible to the discretion of the superintendent and containing means to secure justice to an applicant. Where discretionary powers are vested in a superintendent, that official can be compelled to exercise them in a reasonable manner, for citizens have inviolate rights, but an appeal to courts is expensive and time-consuming. The wiser plan is to frame the building law in such a manner as will avoid serious conflicts between those who erect buildings and those who administer law. It does not follow that what a builder proposes to do or actually does is wrong in itself, for the things a law

may prohibit at one time it may permit at another time, and that which is unlawful in one city may be lawful in another city. A law must be both rigid and flexible, not so straight that it cannot be bent, not so elastic as to be loose.

In manuscript form an ordinary building law is a voluminous writing, and a good memory, a watchful eye, and a clear head are prerequisites for the person who undertakes to keep the record straight in the preparatory stages of the work. Sharp lawyers will eventually probe the law for defects, unearthing a surprising number of defects. Learned judges will be called upon to interpret its meaning, and altogether the law will have to run a gauntlet of legal attacks until it is materially altered and changed, and afterward a new line of legal fire will be opened upon it. In respect to contentions, all the way up to the question of its constitutionality, a building law does not differ from a law relating to excise or to any other subject. It is an old and a trite saying that laws are made to be broken, and lawyers will ever try to break down law itself, But there is an axiom in law that for every wrong there is a remedy, and, while building laws have been lamentably faulty thus far, the process of evolution will better them as time rolls by and greater learning and skill are applied to their production. The drafting of building laws is a new branch of legal science, difficult, calling for a combination of talents, but possible to be done with precision. Building laws have become part of the jurisprudence of this country, and their number will multiply with the growth and increase in the number of cities. The production of wise, equitable, and uniform building laws is an interesting and patriotic work that invites the attention of the American people.

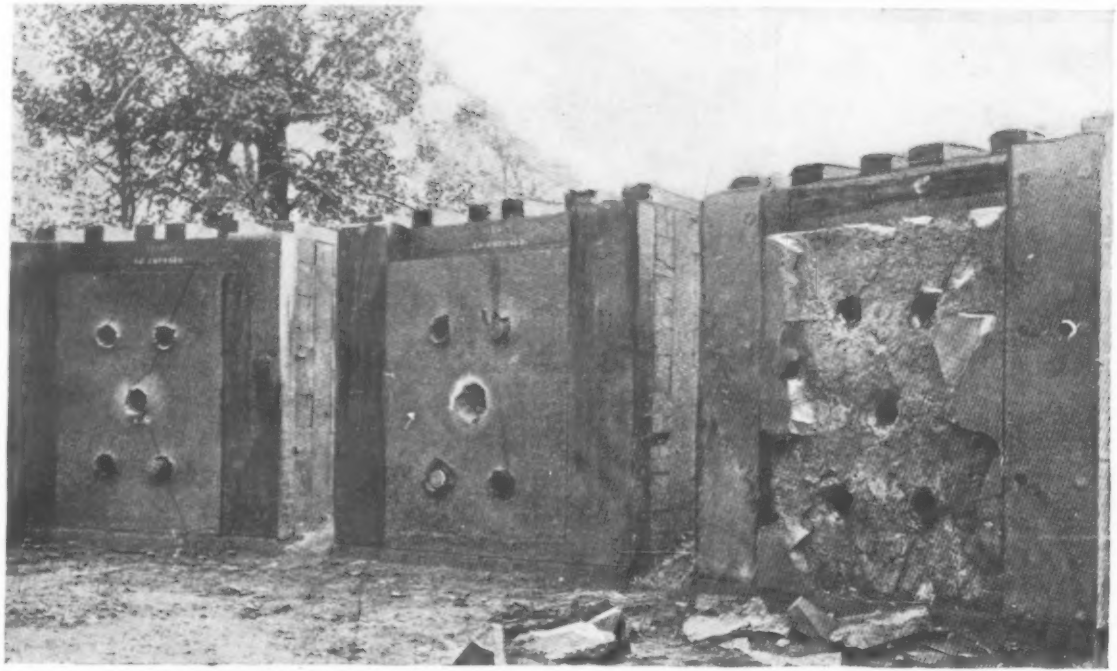
DEVELOPMENT OF THE NICKEL-STEEL ARMOR-PLATE.

By R. B. Dashiell, Ensign U. S. Navy.

AFTER the hurried completion during the late civil war of the monitors with their turrets of laminated iron plating, the United States government made no material progress of any kind in the development of armor until within the present decade. During this interval of nearly thirty years, however, the artillerists and plate-manufacturers of Europe had not been idle, and on foreign proving-grounds—in England, France, Germany, and Russia—the never ending contest between guns and armor was being continually waged with varying success. Laminated iron armor, after a tough resistance to the old-fashioned smooth-bore, yielded to the pointed chilled shot of the rifled gun. Solid iron plates long held the rifle shot at bay, but the increase in the size of the gun and its shot, and the consequent penetrating and smashing power of the latter, were greater than the resistance offered by the increase within practicable limits of the thickness of the plate.

Iron armor reached its full development in 1874 in the 24-inch plates of the English battle-ship *Inflexible*, but even this great vessel could carry barely enough of this armor to protect her vital parts alone. Before this, however, the insufficiency of iron armor was well-known, and experimental plates of two different types were already being tested on both sides of the English Channel. English armor-makers developed and brought to its greatest attainable perfection the compound plate. The French produced the steel plate. Both types appear fairly well developed in the "seventies." Each country clung with great tenacity to its own offspring, with but few advocates among the military authorities in the one for the type developed by the other, so that the two systems have become almost national,—all the later English fighting-ships carrying the compound, and French ships the all-steel plate, although several of the latter nationality have compound armor.

Following the English line of development:—The compound plate consists of a face of hard, but not necessarily "hardened," steel welded to a tough wrought-iron back. The steel face is

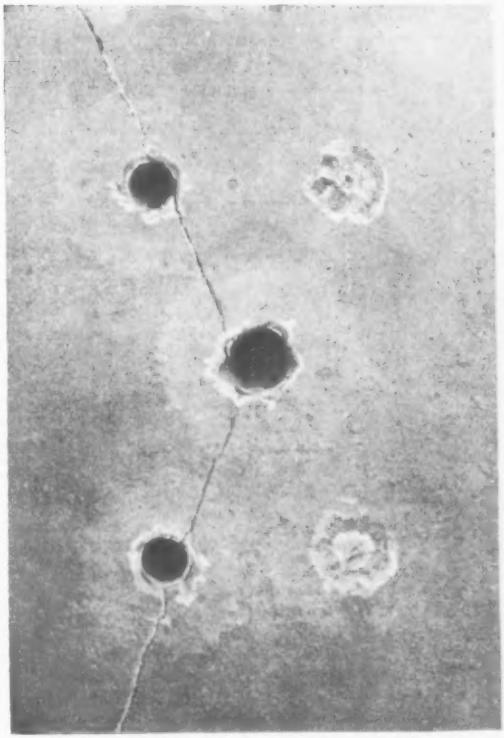


COMPETITIVE TRIALS OF FOREIGN ARMOR-PLATES AT ANNAPOLIS.

Steel Plate. Nickel-steel Plate. Compound Plate.

about one-third the thickness of the whole plate, and its object is to offer great resistance to penetration and breaking-effect on the shot, while the tough iron back prevents the plate from cracking to fragments and falling away piecemeal from the structure it should protect. The system has been quite successful.

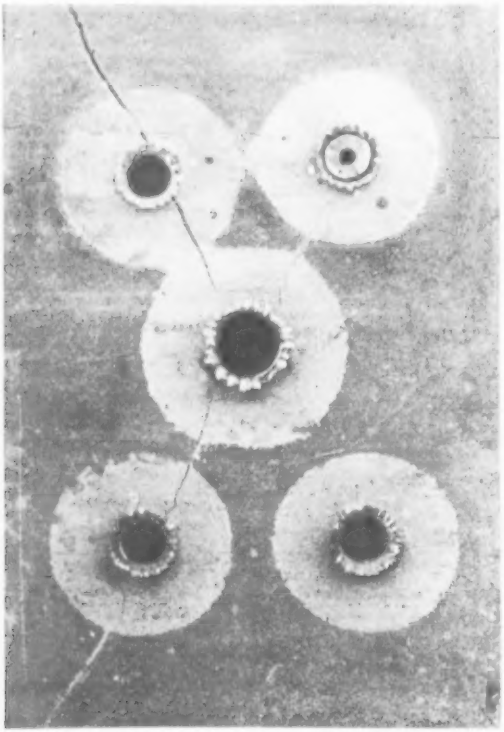
Across the channel, the homogeneous all-steel plate offered both its hardness and toughness to break and stop the projectile and yet remain in good shape upon its backing. But in the meantime a new factor entered the problem in the contemporaneous development of the armor-piercing shell, and both compound and steel plates were soon overmatched; the former were penetrated, the latter cracked and broken by shell which had attained such excellence as to be almost undeformed by impact on a steel plate. In the effort to meet this new element, the carbon of the steel face of the compound plate was carried as high as 1 per cent. to harden the surface and break the projectile, but the danger of the scaling off of the entire face prevented successful results. French armor-makers discovered remarkable projectile-breaking qualities, com-



10.5-INCH HIGH CARBON NICKEL-STEEL PLATE (HARVEYED)—BETHLEHEM IRON CO.

[After four 6-inch and one 8-inch shots.]

bined with great tenacity and resistance, in an alloy of nickel and steel, containing about 3 per cent. of nickel. Experiments showed its possibilities and good qualities even in the early plates, and in 1889-90 the armor-plate of nickel-steel had reached such a stage of development that its existence could not be overlooked by a government seeking the best type of armor for its battle-ships.



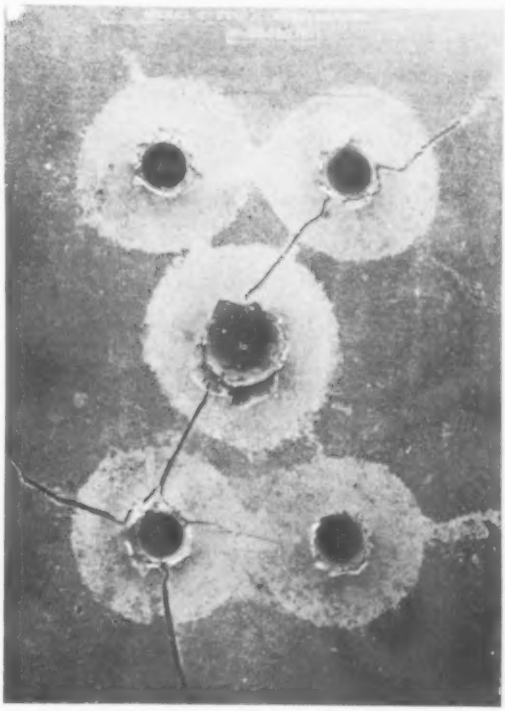
10.5-INCH HIGH CARBON NICKEL-STEEL PLATE—BETHLEHEM IRON CO.
[After four 6-inch and one 8-inch shots.]

In response to the invitation for a competitive trial of armor-plates extended by the Navy Department at Washington to foreign armor-makers—for there was as yet no plant in this country capable of producing a plate of the required thickness—three plates were submitted for test at Annapolis, Maryland, in the summer of 1890. These plates were all of the same dimensions, 6 feet by 8 feet, by 10.5 inches thickness. One was all-steel, one nickel-steel, and one compound. The first two were from the works of Henri Schneider, Le Creûsot, France; the third was from Cammel & Co., Sheffield, England. The three leading types of armor of most recent development were thus represented.

Each plate was submitted to four rounds with the 6-inch gun

firing Holtzer steel shell with a striking velocity of 2075 feet per second, and then to one round from the 8-inch gun firing Firth steel shell with a striking velocity of 1850 ft. per second. These velocities were calculated to drive the shell just through a good homogeneous steel plate. The plates were bolted to oak backings 36 inches thick, which were in turn supported on non-yielding heavy structures of oak timber.*

The trials were conducted by a board of naval officers who unanimously reported in favor of the nickel-steel plate as being the best of the three tested. The nickel-steel and steel plates kept out all shots fired against them, but the latter was badly cracked at its center by the last round from the 8-inch gun. The compound plate was completely penetrated by all projectiles fired at it, and its steel face was destroyed. As has been often the case, the weld between the iron back and the steel face was the weak point in the plate. These trials were by far the most severe that any standard plate had yet been subjected to. They mark an epoch in the



10.5-INCH HIGH CARBON NICKEL-STEEL PLATE—CARNEGIE, PHIPPS & CO.
[After four 6-inch and one 8-inch shots.]

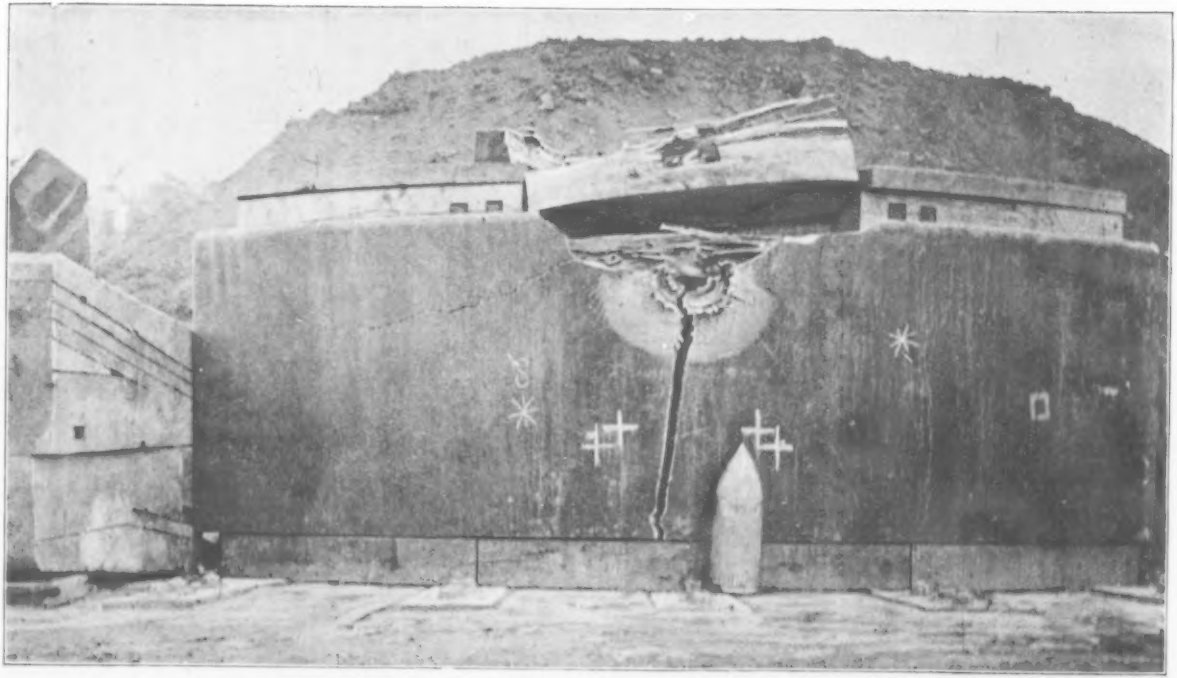
* It will be well to bear in mind that *all* plates are tested on similar structures, so that the conditions of trial are always the same and "standard."

10-INCH STEEL PLATE—BETHLEHEM IRON CO.
[After one 12-inch shot.]

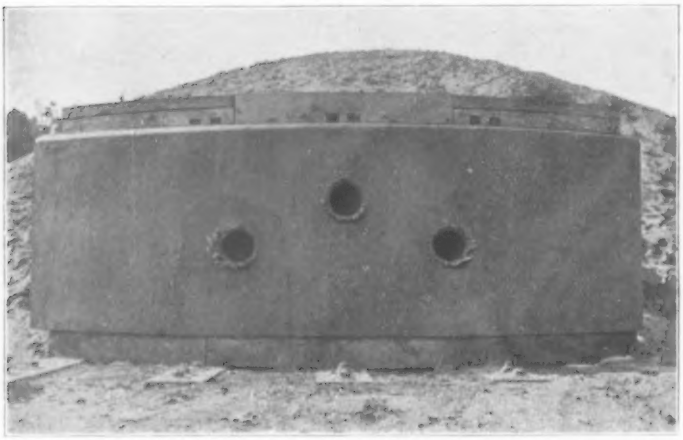
history of armor, and their conditions have become standards for comparison the world over.

As all plates for the new vessels were required by law to be of domestic manufacture, the Bethlehem Iron Company and Carnegie, Phipps & Co., foreseeing the necessities of the future, had for several years been engaged in completing the plants for turning out the armor as soon as the type could be finally decided upon. The first-named company use the hammer in working down the ingot to the plate, while the latter roll their armor. As both firms bid on the armor contracts, further experiment was necessary to settle between these two processes, for it must be borne in mind that the French steel and nickel plates described were hammered plates, and foreign steel-makers have always claimed that a good armor plate must be a hammered plate.

In preparation for this test, several small plates were submitted to firing trials with such gratifying results as to leave little doubt of the successful future of American armor. Plates were therefore manufactured by these firms, of exactly the same dimensions as



11-INCH STEEL ARMOR-PLATE WRECKED BY AN 8-INCH SHELL.



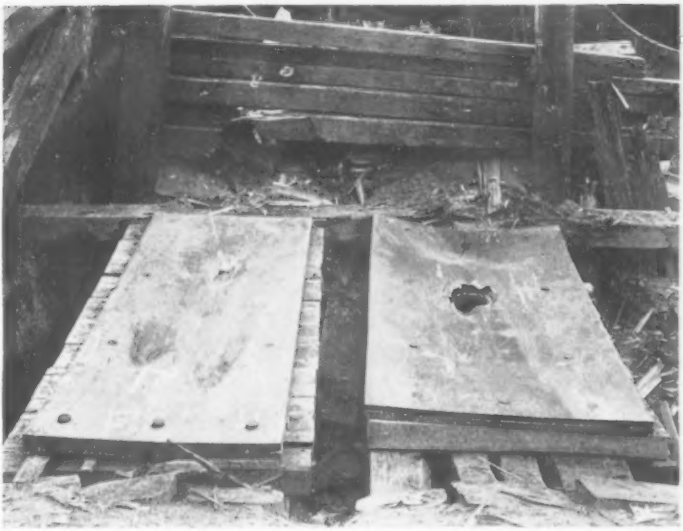
TEST-PLATE OF "MONTERREY'S" BARBETTE ARMOR.

[11-inch Nickel-Steel Armor-Plate after three rounds from the 8-inch gun.]

those of the foreign plates tested in 1890. But as the compound plate became the rival of the solid iron plate in the "seventies," so does the Harveyed plate now appear on the scene, developed but slightly beyond the embryo state, but of such promise for the future as to warrant the entering of four Harveyed plates in the great competitive trial of the eight American plates in 1891. These plates were subjected to practically the same tests as had been given the foreign plates at Annapolis in the preceding year. The firing took place at Indian Head, Maryland, and this trial is the most important and extensive the world has yet seen,—both in the number of plates attacked as well as in the importance of the features in each plate to be decided upon in the competitive tests, viz.: nickel untreated plates *v.* nickel Harveyed plates, or all-steel Harveyed plates; low-carbon nickel *v.* high carbon nickel; rolled *v.* hammered plates; home made plates as compared with foreign plates tested at Annapolis, etc. The amount of information to be derived was enormous.

CROSS-SECTION THROUGH MIDDLE OF PLATE.

The best plate of the eight was the high carbon nickel steel Harveyed from the Bethlehem Iron Company, and a close second was the high-carbon nickel-steel (untreated) plate from the same



STEEL AND NICKEL-STEEL DECK-PLATES.

[After attack by 6-inch gun; steel deck perforated by pointed steel shells.]

firm. The first named was superior, and the second fully equal to the French nickel plate. Nickel steel armor of the first quality and of domestic manufacture was now an established fact. This material was at once adopted for the armor of the new ships, and the United States government was the first in the world to take this important step and adopt this metal which proved itself so superior to plain steel and compound armor.

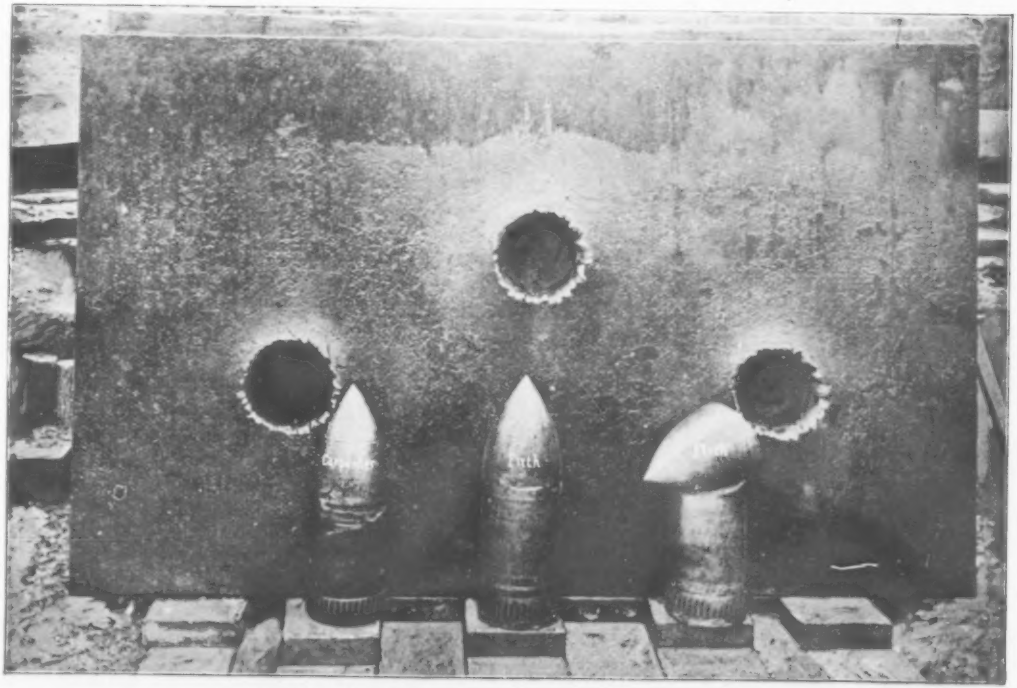
As far as the processes of manufacture were concerned, the hammered plate was found better than the rolled, but the rolled plate proved itself no mean competitor, and all of them behaved so well that, when the cost of production was considered, it was a question as to whether the rolled plate were not the equal if not the superior of the hammered plate.

Three more trials on a smaller scale between steel and nickel must now be noted, for they were trials of material in the shape in which it was to be on board ship,—curved turrets and inclined decks. The curved turret plate was the *Monterey's* test-plate. The barbette or breastwork armor for this vessel had been ordered from the Bethlehem company before the armor trials of 1891, and

SECTION OF 5-INCH NICKEL-STEEL PROTECTIVE DECK OF THE CRUISER "NEW YORK."
[After attack by 8-inch steel shell.]

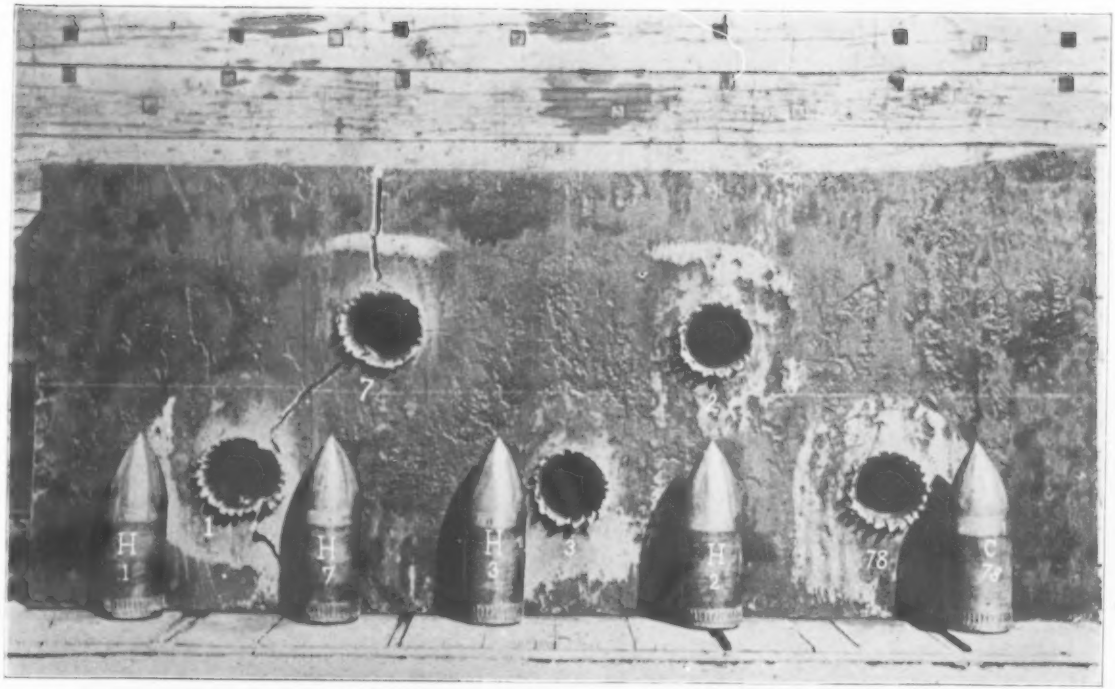
the Navy Department had specified the material to be steel. Before any batch of armor-plates is accepted by the government, one plate from the lot—known as the "test-plate" and usually selected from having some slight defect—is submitted to a ballistic test of three shots at the Proving-Ground. These shots are located on the plate in the apexes of a triangle whose sides are not less than 3½ calibers of the shot in length, and the requirements are that the plate shall not be penetrated nor its backing exposed before the third round. Narrow plates receive the shots in a horizontal line.

The test-plate of the lot of steel armor for the *Monterey* was eleven inches thick and was attacked with the 8-inch gun. It failed at the first shot, cracking from top to bottom and having a large piece knocked out of it. The lot was of course rejected, to be replaced in nickel steel. A few months later the Bethlehem company submitted a nickel-steel test plate of the same dimensions as the rejected steel plate. This plate received its three shots without a crack, all projectiles rebounding a hundred feet to the rear. The *Monterey* is thus the first man-of-war in any navy to carry armor of nickel-steel.



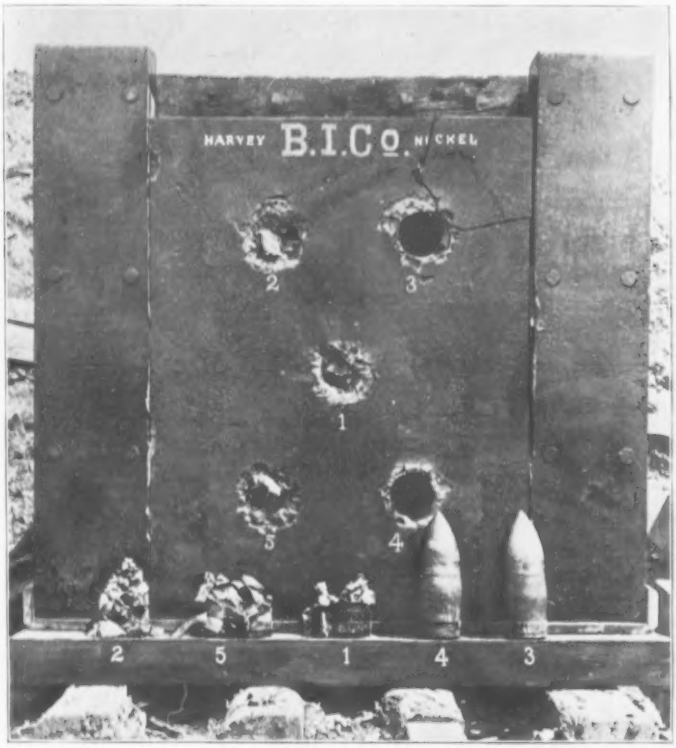
TEST-PLATE OF DIAGONAL ARMOR FOR THE BATTLE-SHIP "INDIANA."

[14-inch nickel-steel plate after three rounds from the 10-inch gun.]



TEST-PLATE FOR DIAGONAL ARMOR OF THE BATTLE-SHIP "MASSACHUSETTS."

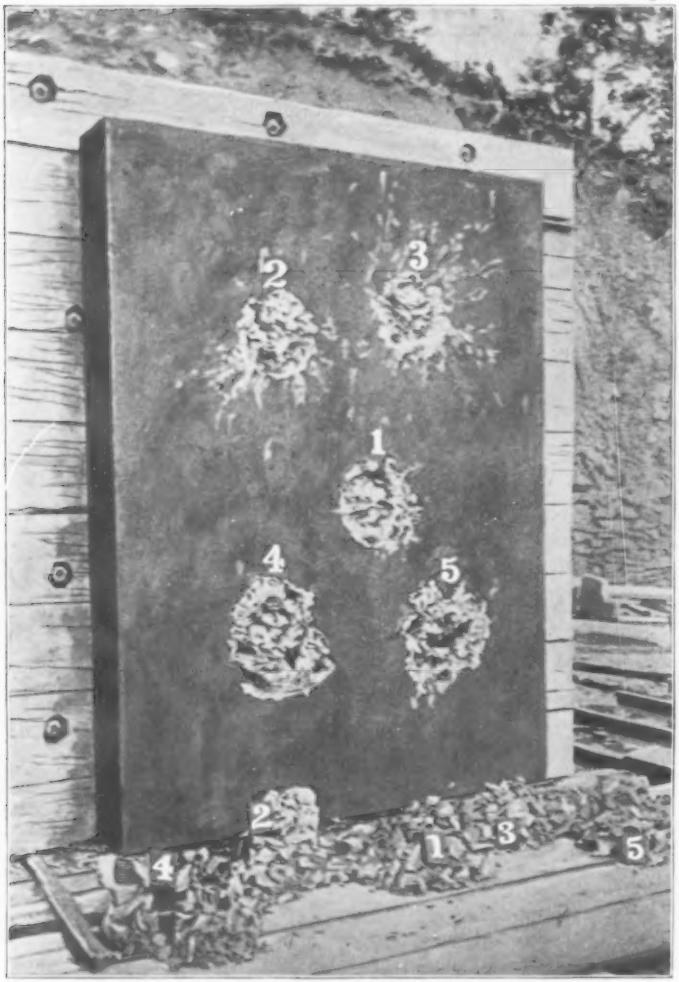
[12-inch Nickel-Steel Plate after five rounds from the 12-inch gun.]



10.5-INCH HARVEY NICKEL—BETHLEHEM IRON CO.

[Cross-section given below shows effect of non-uniform face-hardening after five shots from the 8-inch gun.]

The question of the material for the inclined protective decks of cruisers is a very important one, for it is on the integrity of this deck that the safety of engines, boilers, and magazines depends in these unarmored vessels,—ships such as the *Baltimore* or *Philadelphia*, whose sides can be perforated by a musket-shot. To solve this question, a competitive trial was held at Indian Head between two sections of protective deck three inches thick, one of steel, the other of nickel-steel. These decks were attacked by the 6-inch gun, the line of fire being at an angle of 22



10.5-INCH HARVEYED NICKEL-STEEL PLATE—BETHLEHEM IRON CO.
[Five shots from the 8-inch gun.]

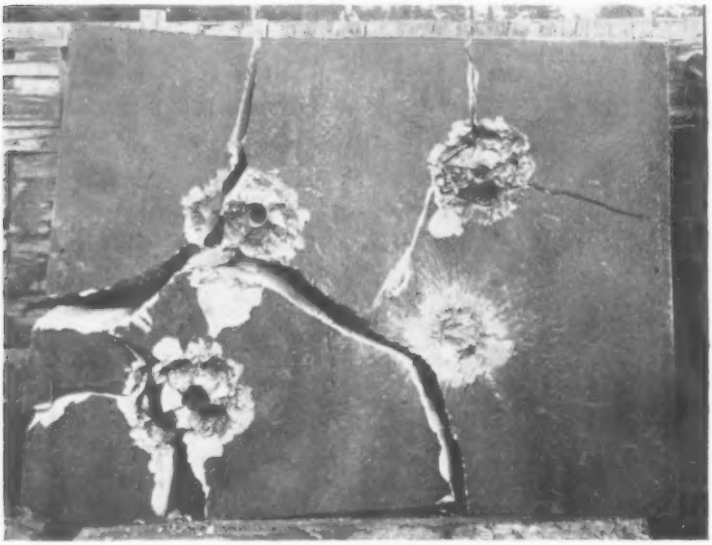
degrees with the surface of the plates. Four common cast-iron shell failed to make any impression upon either plate beyond slight dishing. A steel armor-piercing shell fired with full charge glanced

harmlessly off the nickel-steel deck, while a similar shell with 11 per cent. less energy broke through the steel plate, burst beneath it, and completely wrecked the supporting structure. One such shell would have destroyed a cruiser had it struck near engines or boilers.

Another instructive comparative test of deck plates was something of a surprise in its results. Inclined plates of six inches thickness, representing the armored deck of the cruiser *New York*, were attacked with the 8-inch gun and steel shell. These plates were of steel and nickel-steel and were inclined 22° to the line of fire. The steel plate was badly cracked, but behaved very well, while the nickel-plate was knocked all to pieces as if it had been cast-iron. The cause for this lay in the high amount of carbon,—over forty points,—which had been worked in the steel to make it hard. A similar plate with about thirty points of carbon received all its shots, and deflected and broke them up, without suffering the least injury to itself beyond slight dishing. From the results of these and other similar experiments nickel-steel was adopted for the protective decks of all cruisers and battle ships under construction. All these deck plates are from the Pittsburgh firm and are of admirable qualities.

10-INCH CURVED HARVEY NICKEL PLATE.
[Attacked by 8-inch gun.]

The thickest rolled plate of nickel-steel armor yet turned out is the 13-inch plating for the sides of the *Monterey*. The representative plate passed a successful test with the 10-inch rifle and steel shell of 500 pounds weight. In a short time the Bethlehem firm presented a 14 inch hammered nickel-steel plate representing armor for the new battle-ship *Indiana*. This plate withstood three rounds from the 10-inch gun without a single crack. Its performance may be considered very remarkable.



14-INCH HARVEY NICKEL PLATE.

[After four rounds from the 10-inch gun and Holtzer steel shell with striking velocities of 1472, 1585, 1689, and 2059 feet per second; weight of each shell 500 pounds.]

These plates mark epochs in the development of nickel steel armor. Many other plates of this material had been tried with most gratifying results, but they were thinner than those already mentioned—varying from four to ten inches—and represented groups of armor for the different vessels under construction. Among these thinner plates, two deserve mention as specially excellent,—the 4-inch plate representing the side armor of the cruiser *New York* and the 9-inch armor for the sides of the monitor *Amphitrite*,—both from the rolls of Carnegie, Phipps & Co.

But satisfactory as nickel-steel untreated armor is as compared with its predecessors and rivals, it must be remembered that it is by no means the ideal plate either in theory or practice. It is not enough that an armor-plate stop an enemy's shot from getting into a ship ; more is demanded from the ideal plate. The behavior of a simple nickel-steel plate with regard to the projectile is nearly the same as that of the thick iron plate of twenty-five years ago, only on what might be called a more advanced and higher plane. As the iron plate soon reached its practicable maximum thickness and was superseded by the projectile-breaking compound plate, so the nickel plate for the same reasons will soon yield to some other type,—a plate which can do *more* than stop a projectile. The steel armor-piercing shell will give the nickel untreated plate the death-blow that the chilled iron shot has given the iron plate. The advance in plates has always been met by the advance in quality of projectile. The chilled-iron shot so long favored by the English has given place to American or French steel shell that can penetrate a thick plate of tough nickel-steel with such slight deformation as to permit being fired over again. Bearing this in mind, the necessity for a better plate than untreated nickel steel will be recognized. When a shot strikes a plate and remains entire, the whole energy of the blow goes into the plate and its supporting structure, and the racking effects on the latter are very serious. The shell for instance may rebound and not enter the ship, but if an entire turret crew are stunned and the gun-mountings knocked out of gear, such a shot might do more actual damage than if it had penetrated, and the plate has done but little towards protecting its structure. But if the energy of the blow can be thrown back into the shot itself and be expended in heat, melting or pulverizing the projectile, then the plate and structure are spared by the amount of energy so expended.

This principle was recognized long ago. The problem of a hard face and tough back was not solved satisfactorily by the compound plate ; but it does seem to be settled, for the present at least, by the Harveyed nickel-steel plate. The Harvey process, an American application to armor-plates of the well-known cementation process, consists in laying a good homogeneous plate (preferably of nickel-steel with about 3 per cent. nickel and about thirty points carbon) upon a bed of sand in which it is immersed flush with its face or top. Carbonaceous material is spread evenly over the bare surface, and the plate is heated in a special furnace and kept at a

temperature sufficient to melt cast iron for a period of time found proper by experiment to effect the required carburization. It is then hauled out of the furnace, allowed to cool to a cherry red, cleaned off quickly, and quenched in cold water. The highly carburetted face is thus hardened to a depth of about one-third the thickness of the plate,—the back retaining its original qualities. Harveyed plates can be bent to the curves required, or, if warped, can be straightened under the press. This system has been proved to be thoroughly practicable, and it will be adopted for the new vessels as soon as plates can be had in required numbers.

Nickel-steel, when Harveyed, has always given better results than plain steel so treated. Some of the earlier plates showed a lack of uniformity in treatment, but the latest results have been magnificent. The 10-inch curved and the 10½-inch flat Harvey nickel plates have received 8-inch Holtzer shell which would have perforated the original nickel plates ; the projectiles were smashed on the surface, and the structures behind the plates were practically unharmed, even though the curved plate was broken from lack of a good backing and support to its ends.

A 14-inch Harvey nickel plate, when attacked with the 10-inch gun, broke the world's record for excellent armor. Four steel Holtzer shell, weighing 500 pounds each, were fired against this plate with striking velocities of 1472, 1859, 1957, and 2059 feet per second,—a total energy of 47,551 foot-tons. The last shot was directed at a fragment of the plate weighing only 4 4 tons and with a striking energy of 14,715 foot-tons, or 3344 foot-tons per ton of plate, an energy of attack nine times greater than the most severe ever given an armor plate of any other type at home or abroad. The resistance of the plate was without a parallel in the history of armor. The shell was smashed like all the others, the penetration was less than 11 inches, and the plate, though broken, fully protected the structure to which it was bolted.

The development of the nickel and the Harveyed nickel-steel plates has not been confined to the United States. The progress abroad has been but little behind that made at home, and all foreign results have been most fully corroborative of those obtained in this country. Nickel-steel armor, plain or Harveyed, is unquestionably the best armor known at present for naval purposes, and it should be a source of gratification to the country that this armor has been adopted for the United States Navy,—the first navy in the world to float the nickel-steel armor-plate.

ELECTRICITY AND ELECTRIC GENERATORS.

By Horace F. Parshall, M. Am. Inst. E. E.

OUR best thinkers never expect to know, absolutely, what electricity is, but rather how it is propagated, and how it is related to other phenomena. I think all will agree with me that this is all we can ever expect to know about anything, and that all knowledge is relative. All that science claims to do is to discover the relation between ascertained facts.

I shall first state, perhaps in a somewhat dogmatic fashion, the principal facts that are now thought to be firmly established concerning the nature of electricity :

Electricity cannot be created ; it can only be moved or strained, and only possesses energy when it is in a state of motion or strain.

Electricity possesses something akin to energy, since we cannot change the current flowing in a circuit without an appreciable lapse of time.

All chemical compounds are made in accordance with the electrical properties of the atoms composing the molecules ; in every molecule there is in combination an equal number of positively and negatively electrified atoms.

Electricity such as is generated on the surface of glass when it is rubbed with silk is electricity at rest in a state of strain, and is called *static electricity*.

Electricity generated by an ordinary dynamo or electric battery, known by heating, chemical, or magnetic effects, is electricity in motion, or *current electricity*.

Magnetism, known by the force which it exerts on magnetic bodies and by its capability to rotate a beam of light, is *electricity* in *rotation*.

Heat and light are electricity in a state of *vibration*.

Most of us feel that we know what light is, because of our happening to possess a special sense organ for its appreciation ; but that it is subject to the same laws of reflection, and has the same laws as electro-magnetic induction, the only difference being in the wave lengths (visible light having a mean length of $1/50000''$, while electro-magnetic waves may be $18'$ long), we are not quite prepared by our senses to believe. It has, I suppose, occurred to

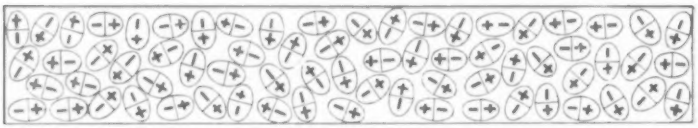


FIGURE 1.

[Arrangement of elementary magnets in an unpolarized magnetic material.]

every one that there may be natural phenomena of which we are ignorant on account of our having no special sense organ for their detection. It is well to bear this in mind when our skepticism of alleged discoveries becomes too marked ; it is also profitable to bear in mind the fallibility of all human testimony.

It is difficult to say to whom we should give most credit for the discovery of the facts that have led to the modern generalizations concerning electricity, but it is admitted by all scientists as fair to give a great deal of credit to our countryman, Benjamin Franklin, who, by his famous "kite experiment," in 1737, succeeded in drawing lightning from the clouds, thus establishing the identity of lightning with electricity. It seems amusing to note that, although his papers on this subject were at first laughed to scorn by the Royal Society of England, at a later time that society had to admit the truth of his experiments, and now the English text-books speak of Franklin's as one of the greatest British names connected with electricity. While his experiments related particularly to static electricity, or electricity in strain, his generalizations were practically those which we are now considering. When we consider the variety and scope of his work, the clearness with which he expressed his ideas and results, and that after the lapse of a century his work in every direction is still regarded as of the highest order, we feel justified in saying that no age or country has produced a more magnificent mind than that of Franklin.

The discoveries that have led to the principal commercial applications of electricity, however, have come to us through a different

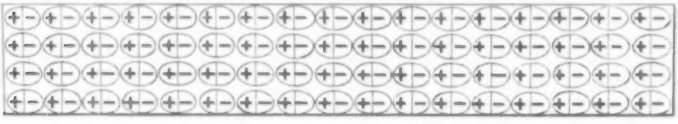


FIGURE 2.

[Arrangement of elementary magnets in a completely polarized magnetic material.]

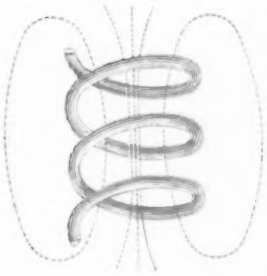


FIGURE 3.

[Amount and direction of magnetic flux due to a magnetizing coil entirely surrounded by air.]

channel. The discoveries of Cavendish, Galvani, Coulomb, and Volta are universally known, and it is due to the work of these men that Oersted, of Copenhagen, 1820, guided by theoretical anticipations, discovered that a current of a galvanic battery acted on a compass needle placed near the conducting wire; then Ampère discovered that currents of electricity attracted or repelled one another, according to their direction. Currents in the same direction attract; in the opposite direction repel. He further showed that the electric current is equivalent in its action to a magnet. Ampere's work seems remarkable when considered either from a mathematical or an experimental standpoint.

In 1825 Arago, of France, commenced his remarkable researches and established the influence of magnetism on all substances. Arago found that the oscillations of a magnetic needle made to swing back and forth over the surface of various materials, such as water, glass, or copper, diminishes more rapidly in the ex-

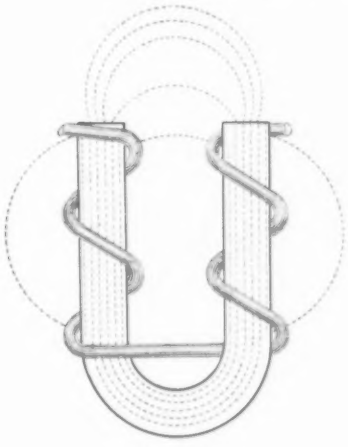


FIGURE 4.

[Amount and direction of magnetic flux due to a magnetizing coil partly surrounded by iron.]

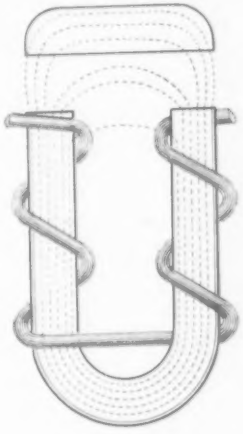


FIGURE 5.

[Amount and direction of magnetic flux due to completely surrounding the magnetizing coil with iron.]

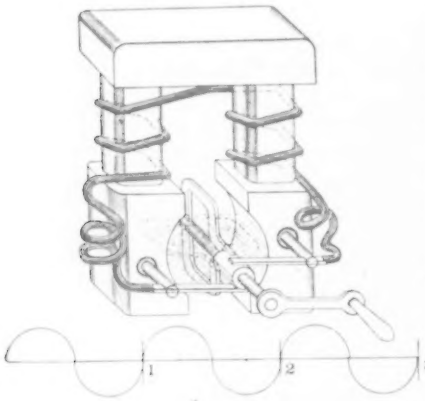


FIGURE 6.

[Elementary form of electric generator, the armature consisting of a single coil rotating between the poles of an electromagnet. The curve shows the electromotive force set up each instant by the motion of the coil.]

tent of its oscillations as it is approached to the surface, and finally discovered, by rotating rapidly a plate of metal near a compass needle free to rotate, that the needle would rotate with the plate. While this experiment embodies the principle of the modern dynamo, it was not understood by Arago, and was left for Faraday to make the generalizations that to-day seem to electricians so wonderful.

Before going further I am anxious to say a word concerning the very interesting character of Arago. Although he has been censured by our Anglican brothers for shrinking from the drudgery of science, the variety, scope, and clearness of his work place him almost beyond comprehension. As an astronomer his photometric measurements of the brightness of the moon and stars, the polar snows of Mars, and the belts of Jupiter and Saturn,—his applications of physics to the structure of the sun as revealed by the spots,—are indeed enough to give one man a lasting fame. It is, however, his investigations in optics that form the most marked feature and the greatest glory of his scientific career. He established

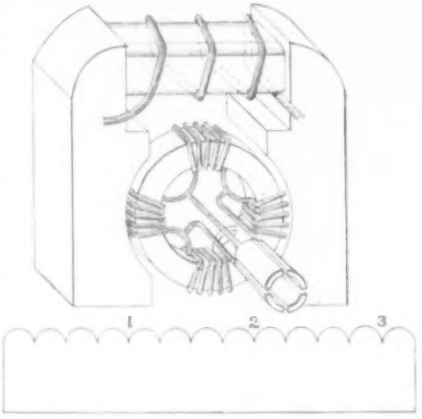


FIGURE 7.

[Elementary form of electric generator, the armature having two sets of coils. The curve shows the diminished fluctuations of electromotive force due to increasing the number of armature coils.]

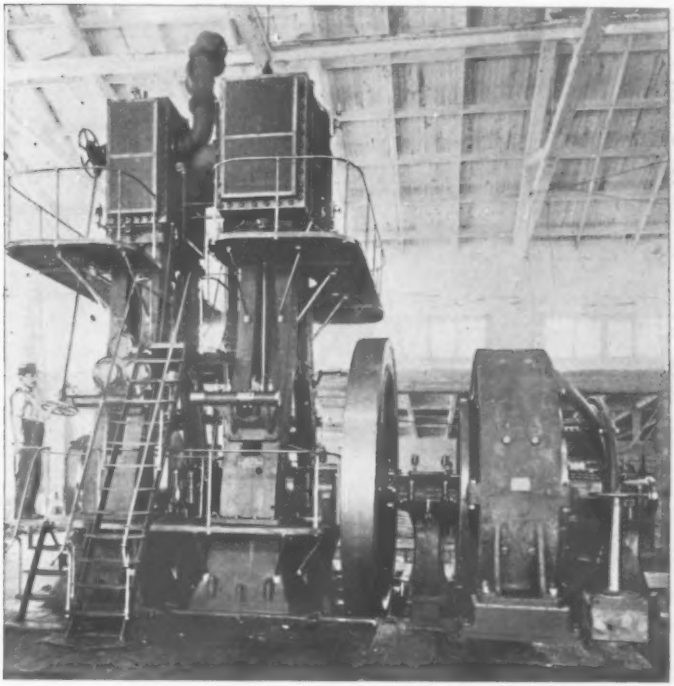


FIGURE 8—RAILWAY GENERATOR, WITH ENGINE.
[10 Pole, 750 Kilowatt, 1000 Horse-Power, 100 Revolution.]

the laws of the interference of polarized light, which involves the idea of transverse vibrations of ether, establishing the wave theory of light. Arago did not confine himself to science, but exerted a powerful political influence in his time as Minister of War and Marine. He also, in 1852, signified his intention to sacrifice his home and office as astronomer rather than take the oath of allegiance required by Louis Napoleon, since he had previously exerted his influence for the abolishment of all political oaths. The prince-president made an exception in Arago's favor, owing to the luster his scientific discoveries had thrown on France.

Almost simultaneously with Arago's work in magnetism, Michael Faraday commenced his researches in electric magnetism, and to-day when one reads the works of these two discoverers the feeling is induced that they seem to have breathed in the laws of

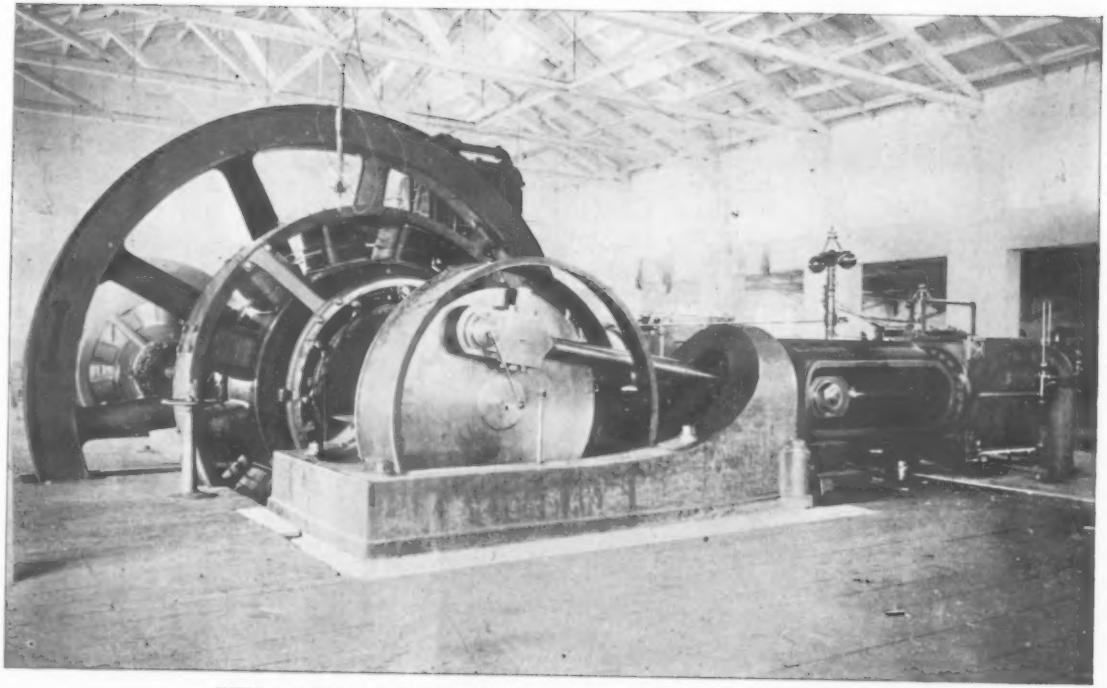


FIGURE 9—12 POLE, 1500 KW. (2000 H.-P.), 75 REVOLUTION RAILWAY GENERATOR, WITH ENGINE.

nature in their subtle form and to have breathed them out again in words so simple and clear that he who will may understand.

In reading Faraday's "Experimental Researches" one feels that he knew intuitively what each experiment would prove. In 1821 he obtained the first evidence that one electric current can induce another in a different circuit, and expressed his ideas so plainly that no one to this day has found a better formula. It is by the application of this one law that nearly every commercial use of electricity is made.

Faraday, in 1845, commenced a series of investigations on the effect of magnetism on light, and found that he could deflect a ray of polarized light with a magnet, thus establishing the relation between light and magnetism. This was at a later time interpreted by Maxwell to mean that the velocity of propagation of light and electro-magnetic induction are the same. Faraday's famous "ice-pail" experiment showed that, when positive electricity is carried in any region, there is simultaneously carried an equal amount of negative electricity; in other words, the amount of electricity in any place is constant.

This fact, together with the fact that electricity behaves like an incompressible, all-pervading, all-penetrating fluid, demonstrates that electricity is not a form of energy, and may be proved some day to be a form of matter. Electricity is material in nature, and does not possess energy unless under pressure or in motion.

Faraday discovered that electricity could be set in motion by reversing or moving a closed coil of wire in the vicinity of an electric magnet, and, since all commercial forms of electric generators are applications of this discovery, it seems warrantable that I should give this most careful explanation.

In the above statements I have assumed that the reader is familiar with the electro-magnet. Probably I have no right to make this assumption, for, if everything that happens in and around this piece of apparatus were definitely known, there would not be much left to learn about electricity.

I will try to start as near the beginning as possible by saying that a wire in which there is a current of electricity is always surrounded by magnetism and capable of exerting magnetic force, the amount of magnetism and the force it is capable of exerting being dependent upon the medium surrounding the wire.

I have stated, in other words, that it was one of Arago's discoveries that all known substances are affected by magnetism. We

account for this by saying that all known substances consist of a great number of minute permanent magnets, similar to compass needles. These magnets, until acted upon by some external force, do not arrange themselves with their poles in any particular direction, and consequently do not exhibit any polarity, since the effect of one elementary magnet is counteracted by the effect of its neighbors. Such a state of affairs is shown in Figure 1 on a greatly magnified scale, each of the small figures representing an elementary magnet.

When, however, an electric current or magnet is brought to bear on a substance, these elementary magnets have a portion of their like poles turned into one direction so that their effects are no longer neutralized. The substance is then said to be polarized. Such an arrangement is shown in Figure 2.

Now, when a wire carrying an electric current is surrounded by air, the amount of magnetism generated near it is very limited, on account of the high resistance of air to polarization. If, however, we surround it with iron, under ordinary conditions, about two thousand times as much magnetism is generated as in air. Iron, in fact, is the only substance that can be very strongly polarized by an electric current. It is common to express this by saying that iron conducts magnetism under ordinary conditions two thousand times better than air. We find, however, that there is a limit to the amount of polarization of which iron is capable.

By referring to Figures 1 and 2, it will be apparent at once that the number of elementary magnets in any place is a limited, definite number, and that after we have turned all these in a certain direction there can be no further polarization. This is exactly what is believed to occur in a substance when it is saturated by magnetism, —*i. e.*, we have turned all of the elementary magnets in one direction. Further, we know by experiment that the amount of magnetism, in any material not saturated, increases with the amount of electricity, and the number of times the electricity passes around it; therefore, to get the greatest amount of magnetism through a piece of iron there must be a great number of turns of wire carrying a strong current around the iron. Under these conditions it is possible to get between two poles of the electro-magnet a pressure of 1000 pounds per square inch, and more.

Figure 3 shows a coil of wire carrying an electric current, with a few lines showing the amount of magnetism that would pass through it if no iron were present. Figure 4 shows such a coil of

wire, in part surrounded by iron, the lines showing an increased amount of magnetism due to the presence of iron. Figure 5 shows such a coil with a complete circuit of iron through it and shows the increased amount of magnetism due to eliminating air entirely from the circuit of magnetism.

If I should revolve a closed coil of wire in front of an electro-magnet, as shown in Figure 4, electricity would be started in motion around the coil.

The amount of electricity set in motion in the coil will depend, among other things, on the amount of magnetism going through the coil from the poles, the number of convolutions in the coil, and the number of revolutions in a given time.

It will be noticed that, when the coil is in one position, it includes all the magnetism, and, when it is at right angles to this position, it includes none. We are then varying the amount of magnetism in the coil. Electricians are in the habit of saying that by rotating a coil we cut the magnetism. This, however, is not literally correct. We simply let it into the coil and take it out again, and the relative motion between the coil and the magnetism (which is electricity in rotation) starts up an electric current in the circuit just the way a rope lying over a lot of loose pulleys commences to move when the pulleys are rotated. When we rotate this coil through the air, there are what we may call, for present purposes, "dead points"; that is, in certain positions, though the coil is rotating, it has no relative motion with respect to the magnetism. In this place the coil is not generating electricity. The electricity generated by a coil rotating in this fashion varies during the rotation from zero to the maximum, and back again, and, when the direction of the coil is reversed with respect to the direction of the magnetism, the current is reversed and electricity flows in the other direction from zero to maximum, and then to zero. This, then, is what is known as an alternating current.

Suppose, as in Figure 5, we laid off in a horizontal line a number of equal distances corresponding to the circumference through which the periphery of this coil rotates with equal angular velocity. The amount of electricity generated at each instant could be shown by a curve. This curve shows what is commonly termed an alternating current. The electricity flows first in one direction and then another through the circuit. In ordinary practice these alternations occur about 200 times a second.

In some recent very interesting experiments, where the alter-

nations were as high as 20,000,000 times a second, it was found possible to light an incandescent lamp through the body of the experimenter without serious consequences, since at this rate of alternations the resistance to the current of electricity was confined entirely to the surface of the conductors. Hence an extremely small current was required to incandescence the filament of the lamp. This interesting experiment demonstrates that the electric current, when passing through a conductor, requires an appreciable time to pass from the surface of the conductor to the center. In ordinary conductors the current will pass from the surface to the center in 1-5000 of a second.

Continuing with the small generator, suppose we had another coil at right angles to the first coil (see Figure 6); while one electric coil was generating no electricity, the other coil would be generating a maximum. The amount of electricity flowing would not vary to such a great extent as it did in the first case. [See Figure 7.]

Now the modern continuous current dynamo consists of a number of these coils connected so that the current is *always* forced through the circuit in the same direction. The number of coils is made so great that there is a constant amount of electricity put in motion. In practice we put a laminated iron cylinder inside the rotating coils (laminated so that useless currents will not be generated in it) to diminish the resistance to the magnetic flow.

If, instead of revolving the coil, as in the first case, we pass a current of electricity from some other source through it, it will rotate, and will exert almost the same force that is necessary to generate that current.

This, then, is an elementary example of an electro-motor, and I may say that there is no scientific difference between an electric motor and a generator; both are constructed in identically the same way. A generator is by reverse function a motor, and *vice versa*.

During the last year I have designed a line of very large generators for the General Electric Company. The largest of these generators to-day is several times larger than any that have been to this time constructed. These generators differ from those that have been in general use in that they are directly connected to the engine,—*i. e.*, the armature is keyed directly to the crank shaft of the engine; thus all belting is done away with, likewise considerable noise and liability to accident. Two of the largest sizes of these

generators are in operation at the power station of the Intramural Railroad of the Columbian Exposition. The smaller one, shown with an Erie Vertical Engine in Figure 8, has a nominal output of 1000 horse-power at 100 revolutions, but has been worked up to nearly double this output without giving the slightest trouble. This smaller generator is capable of satisfactorily operating sixteen trains of four cars each, such as are now in operation on the intramural railroad.

The largest of these generators has a nominal output of 2000 horse-power at 75 revolutions, shown with an Allis Corliss engine in Figure 9. This generator weighs, approximately, 100 tons, and has in its construction steel castings that weigh 30,000 pounds. The armature (*i. e.*, the rotating member) is 10′ 6″ in diameter, and weighs, approximately, forty tons. The shaft is of forged steel and is 24″ in diameter. The weight of the engine is 300 tons, making the total weight of the combined plant—*i. e.*, engine and dynamo—400 tons. On account of the great weight and size of some of the parts, the dynamo was assembled and tested for the first time at the intramural power-station. Upon trial it was found to perfectly meet the conditions for which it was designed.

The most difficult problem involved in the construction of these generators is that of regulation. In practice the load is liable to vary from no load to 50 per cent. overload in a fraction of a minute, and unless there is a perfect balance between the armature and the field magnets there will be most vicious sparking of the commutator, and not infrequently in badly-designed machines the generator will flash,—*i. e.*, the sparking will extend all around the commutator and divert the current from the external circuit to the destruction of the generator and the danger of attendants. This phenomenon is most startling, and I am unable to adequately describe it. It is sufficient to say that such flashing will destroy everything in its course.

The other problems are: To calculate definitely the amount of magnetism to be generated at the magnet poles, the amount of iron necessary to carry this magnetism, the number of conductors that have to be placed on the armature (which is the scientific name for the revolving coil of wire described above), and the amount of heat generated by the resistance of its circuits to the passage of the electric currents generated. This last sentence may require further explanation.

It has been found by experiment that, when there is a passage

of electricity through any conductor, there is always a certain amount of heat generated in that conductor. Just how this heat is generated I am unable to say from an experimental standpoint. I believe, however, that what happens is explainable on the supposition that each of the molecules composing the wire becomes agitated when placed under electric pressure and communicates its charge to the adjacent molecules, thus causing a current to pass. The motion of these molecules is accompanied with something akin to friction, and to this is due the heat. In commercial applications we use copper, since, with the exception of silver, this is the best conductor of electricity.

The amount of energy dissipated in the form of heat in a circuit with a given current of electricity has been definitely determined by experiment, and is always the same. In large generators the amount of heat generated in each portion of the machine must be most carefully determined, since, if any part of the machine becomes unduly hot, it is liable to break down ; or, in other words, a "burn-out," as practical people are wont to call it, occurs.

The amount of damage that can be done by a misdirected electric current can hardly be estimated by one who has not witnessed it. It would be possible to volatilize a round iron rod $1\frac{1}{2}$ inches in diameter by connecting it to the terminals of the second of the large generators previously mentioned. In fact, if a workman should accidentally connect the terminals of this machine by a crowbar, it is rather doubtful whether he would ever realize what had happened to the bar, since a good part of it would pass off in the form of metallic vapor, and it is somewhat doubtful whether he would know, for a while at least; what had happened to himself.

DISTANCE NOT A FACTOR IN THE COST OF RAILWAY TRAFFIC.

By James L. Cowles.

WHEN a train starts from Boston to San Francisco, it is impossible to tell the difference *in cost*, whether a passenger leaves that train at the first station out of Boston, or goes through to the Pacific coast.

"The proper basis of railroad tariffs is the cost of transportation," said Mr. Albert Fink to the Hepburn committee of the New York Legislature. Since distance costs practically nothing in the carriage of freight or passengers by rail, the charge should be the same for the longest distance as for the shortest. The ton-mile and passenger-mile basis of rates—wrong in principle and infinitely vicious in practice—is the root of the gravest evils in the railway business.

The best interests of the railways and of the people demand that on every railway system the rate for transportation between the two nearest stations at which trains stop shall be adopted as the common rate between any two stations on that system, regardless of distance and volume of traffic. This may be called the natural law of railway transportation. The railways are the main circulating system of the country, built especially for the development—the *harmonious development*—of the districts through which they run. An ideal condition will be attained when the consolidation of railway systems, now under way, has been completed, and the lowest rate charged between any two stations in each particular class of service has been adopted as the standard rate for such service between all the railway stations in our country.

The standard rate on passenger way-trains in the eastern part of the United States, under this rule, would be five cents per trip, and on express trains the rates would be practically in inverse proportion to the number of stops. If the stops on the express were one-fourth as many as on the way-train, the rates would be four times as much as on the way-train. Again, since Pullman cars weigh nearly twice as much as ordinary cars, and cost twice as much, while carrying hardly half as many passengers, the rates by Pullman cars would be *at least* four times as much as by ordinary cars.

President Roberts, of the Pennsylvania railroad, testified before the Interstate Commerce Committee of Congress last winter that passengers who traveled in Pullman cars did not pay half the cost of their transportation, and those who dined on the cars did not pay a quarter of the cost of their dinners. "It is the poor man," he said, "who sits in a common car, and sits two or three on a seat, who supports the railways of the country." Now, this practice should be changed. People who travel *en prince* must pay their share of the expense.

The freight rate per haul, on coal and products of its class, carried in open cars, and loaded and unloaded by shippers and consignees, might be 25 cents per ton. With a reasonable use of railway equipment it would be possible to discard both the tonnage rate and classification on open cars and make the standard rate per haul $7 per car of thirty tons. The rates on grain could be reduced to $1 per ton per haul, and on other commodities there could be corresponding reductions.

It must be patent to every one that the building of a railway implies the running of trains, and that these trains must run, whether they go well filled, or nearly empty. The weight of the lightest train, consisting of locomotive and tender, baggage-car, and one passenger-car, can hardly be less than 90 tons. If every seat should be filled, the weight of the train would be hardly increased five tons, the average weight of passengers not exceeding 150 pounds. What difference can it make in the *cost* of running that train whether it be full or empty?

At every station some passengers will be left, others will take their places. Perhaps one in a thousand will take the whole trip. There will always be room for him. And what is true of passengers is equally true of freight. The reason why railway transportation now costs so much per ton and per passenger is the mistaken policy of railway managers, which prohibits the proper use of their cars. Every passenger pays not only for the seat he occupies, but for a half-dozen seats kept empty by high rates; every freighter pays not only for the moving of his goods, but for the haulage of trains not used to a third part of their capacity. They are empty because high rates and discriminations in rates prevent their use. The load of the average passenger-train of the country is 41 passengers. The average freight train-load is only 175 tons. Not only are the loads of trains far below their capacity, but, as the editor of the *Railway Review* says:

The average *car movement* of the country is absurdly small, and it is so mainly because of the misuse of the car by the railways themselves. Mr. W. H. Wheatly estimates the waste of capital in this misused equipment to be $124,000,000, with an interest account of at least $5,000,000. The cost of maintenance of this *useless* equipment is about $10,000,000 per year, to say nothing of the cost of track-room to hold them, locomotives to move them, and the other minor, yet necessary, expenses which their existence involves.

If the 1,100,000 freight-cars in service in the United States in 1890 had made but two paying hauls a week, at $7 per car per haul, irrespective of distance and of classification, their earnings would have been over $800,000,000, whereas their actual earnings were $714,464,277. If the passenger-trains that year had averaged 100 passengers each, instead of 41, they would have earned, *at 25 cents a passenger per trip*, over $300,000,000, instead of only $260,786,453. It is to be remembered that 100 passengers fill hardly three-fourths the seating capacity of two passenger-cars, and that those cars are emptied, on an average, every twenty-five miles. According to the statement made by Mr. Depew, president of the New York Central, before the Interstate Commerce Committee of the House of Representatives last winter, it appears that, while freight rates have been reduced *but one half*, the cost of handling freight has been reduced *five fold*. "So that we can carry *1000 tons now as easily as we formerly could 200*." The rates, therefore, instead of being *one-half*, should be but *one-fifth* as much as they *were formerly*.

Is there not some opportunity for increasing the number of passengers and of tons of freight carried on our roads and *making a proportionate decrease of rates*, without increase of operating expenses? Would not the scheme here suggested produce exactly this result? The essential thing to keep in mind is that differences in the train-loads make no practical difference in the cost of moving the trains. Mr. Stroudley, locomotive-superintendent of the London, Brighton and South Coast railway, says that in a locomotive of his design one pound of coal will convey a ton of train-load 13.5 miles, at an average speed of 43 38 miles per hour. At that rate a ton of coal costing $4 would carry a ton of freight round the world, on a well-constructed railway, in less than a month, and 250 pounds of coal would carry 10 passengers weighing 200 pounds each from New York to the Golden Gate in about three days. Mr. W. M. Acworth says that an English locomotive with a load of 50 tons will burn 20 pounds of coal per mile; when hauling 600 tons, it will burn perhaps 60 pounds, so that between no

load and a long, heavily-laden train the variation of *locomotive-cost per mile* is hardly more than the cost of 40 pounds of coal, say 8 cents. Mr. A. M. Wellington, in his work, "The Economic Theory of Railway Location," says that "the addition of 30 tons dead weight (and live weight is no heavier than dead weight) to a train of, say, five cars, will not increase the expense for coal in this country over one cent a mile." Since all the passengers that can be squeezed into five cars will not weigh 30 tons, it therefore follows that the difference in the cost of fuel on a five-car train carrying 340 passengers and such a train with no passengers is not more than one cent a mile. The addition of three cars to a five-car train will require only 22 pounds more coal per mile, costing perhaps four cents; and the only other additional expense will be the wages of one or two extra hands, interest on the cost of three extra cars, and their repairs. If this five-car train be scheduled to run from Boston to San Francisco, the addition of three cars capable of carrying 200 more passengers will not cost over $200, or *$1 per passenger*.

As to increased wear of track from heavier trains, three-fourths of that expense is due to the locomotive, so that it makes practically no difference in this respect whether a locomotive runs alone or with a train of full-loaded cars. Professor Hadley says:

> On any line where a good canal can run, a railroad can handle a net train load of 600 tons, at a direct expense, for fuel, trainmen, and train repairs,—*that is for haulage*,—of not over 40 cents, and sometimes as low as 30 cents, or from *1/20 to 1/15 of a cent per ton* per mile. In other words, the cost of transporting a net train load of 600 tons across the continent would be only from $900 to $1200; or from $1.50 to $2 per ton on any line where a good canal could run.

But since single engines in the United States have hauled trains of 1200 and 1300 tons, I think it only fair to assume that the rate per ton on such trains would not be above Professor Hadley's figures, although it is necessary on the trans-continental trips to go over very high grades. For the average haul of the country (120 miles) the cost of haulage of a net train-load is not over $48, and may be as low as $36, or from 6 to 8 cents *per ton per haul*; for New England *the rate per ton for* the *average* haul of 70 miles will vary from 3½ to 4½ cents.

These facts prove that the cost of moving one ton or one passenger, on heavy through trains, even for the longest journey, is very small, and on short trips it is infinitesimal. Taking all the circumstances together, I believe that the cost per ton and per pas-

senger is practically the same on the heavily-laden through-train and on the comparatively light way-train. First, the through locomotive hauls on an average a larger number of full-loaded freight cars than does the way locomotive. Mr. Fink makes the average load of the through-freight car nearly three times that of the way-car. Through trains have been run from Chicago to New York with 40 and 45 full-loaded cars of 30 tons each.

Again, the through train runs much faster than the way-train. It wastes neither the time nor the fuel lost by the way-train in frequent stops. On the Manhattan elevated roads of New York it is estimated that three-quarters of the coal consumed and one-third of the time occupied are lost in stops. Our fast freight trains make 350 miles a day, and some of our fastest expresses run 1000 miles a day. The way freight-train hardly makes 90 miles, and the way passenger-train averages less than 100 miles a day. The way-train then must make three or four short trips in order to handle as much freight as is handled by the through train in one long trip. It is probable that our through locomotives handle more tons of freight per locomotive per year than do way locomotives of the same capacity. Instead of consuming time and fuel in stops, the through locomotive occupies itself in flying between its widely-separated terminals. The cost of loading and unloading through freight, which often runs in car-loads, is less than the cost of handling way-freight, which usually runs in small consignments. In Chicago it was found to cost 23 cents per ton for handling way freight in lots smaller than car-loads, and only 9 cents per ton for handling car-loads of through freights.

But the average passenger trip and the average haul of freight will always be short. If railway transportation were absolutely free, the world would not go flying, neither would any country be flooded with the products of any other. Under any circumstances the average trip of the traveler by rail in the United States would probably be no greater than it has been for the last eight years, —about 25 miles. And the average haul per ton of freight would not be over 125 miles, a fair day's haul.

The masses must always labor for their bread. They can seldom spare the time for more than an hour's journey from home. Their factories, shops, schools, and pleasure-resorts must always be near at hand. The bulk of the freight business must always consist in the exchange of products between neighbors. This, indeed, is the prime object of railways. "The through business," says Mr. Fink,

"is but *a mere incident of a road.* The mainstay of a road, is or ought to be, local traffic." The "local traffic" of the Pennsylvania road, in 1881-85, was ten times greater than the "through traffic," and of the two the way-traffic continues to increase much the more rapidly.

I have now demonstrated that distance costs practically nothing in railway transportation. A man or a ton of freight is no more to a railway-train than a fly is to an elephant. And a train load of passengers is no more to a train than a swarm of flies is to an elephant. It is no more possible to measure the difference in the cost of hauling a passenger or a ton of freight over different lengths of a railroad system than it is to measure the difference in the efforts of the human heart, whether the blood is carried from one valve of the heart to the other or from the life-center to the finger tips. The railways are the main circulating system of the country; the tracks are the arteries and veins, and the train the life-bearing current. The harmonious and healthy development of the country, and of the railways as well, requires that the flow of this life-current shall be regulated by a law as uniform and stable as that regulating the flow of blood in the human body.

The post-office system, in which the rate adopted for the shortest distance between stops on any route, is the rate for all distances, and which secures to every individual the same rate for the same class of service, offers the very law we need. For fifty years this principle has determined the world's practice in the transportation of letters and newspapers. Now a two cent stamp will send a letter from Eastport, Maine, to Seattle, in Washington. Is there any essential difference between the transportation of the mails and the transportation of other freight and of passengers? On some railways the mails *weigh* almost a tenth as much as the passengers carried, and the actual income of American railways from the carriage of the mails in 1890 was nearly one-tenth as much as from the passenger traffic.

But the test of this principle has not been confined to the transportation of mail-matter. It has been adopted almost universally on the supplementary circulating systems,—namely, on horse-car lines and electric tramways. We have a remarkable instance of its magical influence in the case of the elevated railways of New York. For two years I watched its working in Birmingham, Alabama, and saw what had been accomplished by its application, in the building up of the ironworks of that district. The rates on

the raw materials of the iron manufacture were 25 cents a ton from any one station to any other on the Birmingham mineral road, within twenty miles of the center of the city. For a year past I have watched the influence of the five-cent rate per trip on the electric lines about Boston.

We have all heard what the application of the postal principle, in a restricted form, has accomplished on the Hungarian railways. In the first eight months of the experiment the general traffic increased 169 per cent. over that of the last corresponding eight months of the old system, while the traffic between neighboring stations increased still more rapidly; from 225,000 to 4,367,586, without any increase of operating expenses, while the receipts increased 18 per cent. Instances are not wanting of the use of this principle on the general railway system of this country. The rate from New York to Birmingham is the same by several different routes, though the route in one case may be half as long again as in another. The grouping of freight rates is very common. The rates are the same for the same class of products from different points in New England to the same commercial center in the west. Coal rates are the same from New Haven, Connecticut, to Mt. Carmel, nine miles distant, and to Westfield, sixty miles away.

There is however no *common law* observed in the determination of railroad tariffs. Through tariffs between terminals are based, as the *Railway Review* tersely puts it, on "guess work modified by a comparison," and the comparison always favors the big dealer and the big terminal. In local traffic, where the power of the railway manager is absolute, ton miles and passenger-miles are measured out with the greatest care, notwithstanding it has been condemned by some of the highest authorities in the railway world. At a meeting of the American Railway Association (representing two-thirds of the mileage of the United States) held in New York, in October, 1891, the president, Mr. H. S. Haines (who is also vice president of the Plant railway system), declared the ton-mile unit to be fallacious, misleading, and without value to the railway traffic manager, and the unit of cost per passenger mile to be equally fallacious and valueless. "*The entrance of a single passenger in a train adds nothing to the cost of moving that train, and the cost of transporting a single passenger is therefore inappreciable.*" A passenger does not measure his desire to get to a place by the number of miles he must travel to reach it, and "whether he goes fifty or sixty miles [yes, whether he goes one mile or 3000]

it costs the same to carry him if the train be scheduled for the longer distance and there be room for him." . . . . "The idea of rate for distance does not prevail in making freight rates." Then why do railway officials continue to make their reports on the mileage basis and to measure out miles so carefully in local rate-sheets? The answer is easily given. "It is not," says Mr. Wellington, "because there is any natural equity in it, neither is it because it is in accordance with the public interest. As a question of purely public policy, the effect of distance on revenue should not be considered at all." It is because the local traveler *thinks* that distance is the main factor in the cost of railway traffic, and because it seems to the railway manager to be profitable to foster this idea, although he knows it to be fallacious, and begs his friends not to do him the injustice to imagine that he is controlled by it in (*through*) business. As for profits, it enables the railway manager to exact from the local traffic rates 50 to 75 per cent. higher than are levied upon through traffic. To this extent the *false* mileage-system of rates burdens small cities and small dealers more than the larger cities and the larger dealers.

Mr. Wellington also says that this further evil follows: namely, where rates are actually determined by distance alone, any *reduction* of *distance* would be apt to entail a loss upon the company. "For example, it would undoubtedly entail a net loss on the New York Central railroad, *from their way business alone*, to shorten their lines by several miles, *even if it could be done without cost to them*, provided all their business, 'way' as well as 'through,' had to be transported over the new line." Taking the average train-load at 100 passengers, one half will be local passengers subject to the full tariff of two cents a mile. The gross revenue from fifty local travelers will be $1 per mile, but the cost of running the train a mile is not over 60 cents. The net revenue, therefore, of 40 cents per train per mile now exacted from local travelers would be lost for every mile cut out of the line. In other words, under this false mileage-basis of rates the fifty local travelers on each train are compelled to pay not only a profit of 40 cents a mile above the cost of their own transportation, but also to pay the entire cost of the transportation of fifty through passengers. This business is so profitable, says Mr. Wellington, "that we seem driven to the conclusion that it is rather worse than money thrown away for the average road to spend money in shortening its line." The more miles between stations, the more miles to be taxed to the local traveler.

It only remains to add that, under this misleading and unfair system of rates, according to the testimony of President Depew before the Interstate Commerce Committee of the House of Representatives, last winter, the smaller places and the smaller dealers of the country, obliged to pay these high local rates, are being rapidly wiped out of existence, and the business of the country is concentrating itself in the large terminals and in the hands of the larger dealers who obtain low through rates *regardless of distance.* Mr. Depew attributes this evil tendency to the Interstate Commerce act, and he is reported to have said before a committee of the United States Senate:

> It is a matter of time only when the small dealer who is compelled to pay the regular tariff will go to the wall. If this law, the Interstate Commerce law, continues in force five years longer, there will not be an independent business man in any of the large cities of the United States.

But the present condition, I respectfully submit, is not due to the anti-pooling section of the Interstate Commerce act, or to any other act of Congress, but rather to those whom Mr. Bryce, in "The American Commonwealth," has styled our "railway kings," —who, to the injury of the railways and of the people, have placed their arbitrary wills above the *natural law of railroad intercourse.*

"An ideal transportation system," says Mr. E. Porter Alexander, in his "Railway Practice," "would be one in which any shipper might sit quietly in his office and contract to deliver freight at any town in the United States, by referring to a printed tariff, which should show rates as uniform as the rates of postage and not exorbitant in amount." This ideal system is the postal system, which makes the rate for the shortest distance, for any particular service, the rate for all distances, regardless of amount of business. It is reasonable, practicable, just. Once recognized and adopted as the law of motion in our great circulating system, most of the evils of that system will vanish like the mist before the rising sun.

ELECTRICITY.

Conducted by Franklin L. Pope.

A PARLIAMENTARY committee which was appointed to take evidence and report a bill for regulating the future relations between the electric traction and the telephone systems, particularly in respect to electric interference arising from the mutual use of the earth as a return circuit—a matter which has given rise to more or less litigation in Great Britain as well as in America—has recommended legislation compelling tramway companies to use metallic return conductors of low resistance, and to use all reasonable precautions to avoid interference with telegraph or telephone circuits, or injury to gas or water pipes by electrolytic action. On the other hand, the telegraph and telephone companies are to lose their right of action against the tramways, after the expiration of a certain number of years, if in the meantime they have not done away with the use of the earth as a return circuit. The committee express the opinion that the injuries to gas- and water-pipes which have been complained of are due mainly to a faulty system of construction, and that the difficulty may be practically eliminated by proper attention to the arrangement and construction of the circuits. They further express the opinion that there is in fact but little demand for new tramway lines, and moreover that there is no money in tramways in Great Britain.

CASES sometimes happen in the location of a street-railway in which a very severe grade is unavoidable for a short distance, while the remainder of the line is comparatively level. To meet this condition of affairs a very ingenious device has been invented, and has been for more than two years in successful operation on a line in Seattle, Washington. For a distance of 1000 feet there is a grade varying from 11 to 16 per cent. Two counterbalance weights, aggregating six tons, run on rails laid in a conduit underneath the track. These weights exactly balance an empty car, and are attached to wire ropes running over pulleys. At the top of the grade, on its way down, the car picks up the rope, and in descending hauls the weights up, thus checking its own speed so that the brakes will hold the load without difficulty. At the foot of the grade the conductor disengages the rope by a hand-lever. Going up, the connection is made automatically, and disengaged in a similar manner. A grade of 20 per cent. may be readily overcome by means of this simple and admirable expedient.

THE most extensive attempt to operate an electric street-railway by means of an underground conduit of which we have any knowledge is that which has heretofore been referred to in these notes in Budapest, Hungary. It is now officially stated that 14,000,000 passengers were carried on this road in 1892, as against 8,500,000 in 1891, the net receipts for the last year being sufficient to carry forward a surplus of over $10,000 after the payment of a dividend of 10 per cent. There has been some talk of trying this system in this country, and in view of the above results it would seem well worth while to do it.

A THIRTY-TON electric locomotive recently completed at Lynn, Massachusetts, has been sent to the World's Fair for exhibition. It is intended for elevated or suburban traffic, and is calculated for a normal speed of about thirty miles per hour. It has 44-inch wheels, and a separate motor for each axle. The tractive effort is figured at 6000 pounds. The air-brake and whistle are supplied with compressed air by a special pump driven by an independent motor. The performance of the engine, on trial trips, has proved entirely satisfactory.

AT a particularly dangerous grade-crossing of a steam and electric railway, in the suburbs of Boston, we noticed not long since that a stout team of horses was attached to each electric car and driven over the crossing in front of it. This is by no means an unnecessary precaution. An electric car is far more likely to be stalled on the frogs of a crossing than anywhere else, for the double reason that the electric connection through the track is necessarily imperfect, while the unavoidable bouncing of the car is very liable at the same time to throw the trolley off the wire. Yet we noticed not long since that a court had declined to interfere with the establishment of such a crossing, on the ground that it could be no more dangerous to cross by electric power than by horse-power. That judge will live, it is to be hoped, to see that he has made an error; on the other hand, he may be killed on that very crossing so quickly that he will never have time to suspect that it was his own fault.

THE Brooklyn City Railway Company have completed an immense house for the storage of electric cars. It is built on a hillside, and cars can be run into it from the street-level at three different stories. The main building is 700 feet long and 200 feet wide, contains 6½ miles of track, and is capable of accommodating 1000 34-foot cars at once. Connected with the building are shops for repairs and refitting.

THE electric cars of the Lynn and Boston railway have been fitted with air-brakes, the air being compressed by a pump driven from the axle of the car while in motion. A pressure of about thirty pounds is found to be amply sufficient for the purpose. The brake is so arranged that the motorman can apply it by a pressure of his foot. This improvement will doubtless greatly reduce the number of street accidents.

AS a result of a careful series of experiments, it has been found possible to magnetically screen a dynamo-electric machine to a sufficient extent to permit it to be used for furnishing electric light to the Greenwich observatory, without interfering with the extremely delicate magnetic measurements which are being carried on at that station.

ONE of the ever-present dangers in large electric lighting stations is the possibility of a governor belt breaking or going off the pulley, thereby permitting the speed of the machinery to increase enormously before the engineer has time to shut off steam. Within a few years several serious disasters have occurred from the bursting of large fly-wheels from excessive speed, which in their destructive effects have often been only second to a boiler explosion. W. M. Stine, writing in the *Electrical Engineer*, proposes to arrange a balanced shut-off valve in such a manner that it will be actuated instantly by an abnormal increase in the amperage or voltage of the current. This may be done by means of a small special motor or an electro-magnet, and in other ways which will readily suggest themselves.

A CONNECTICUT manufacturing company has lately completed a search-light having a lens and mirror each five feet in diameter, which is computed to be able to emit a light of 375,000,000 candle-power.

THE city of Allegheny, Pennsylvania, has been lighted for a number of years by clusters of electric arc-lamps placed upon high towers of steel framework. The system has failed to give satisfaction, and the towers are now being replaced with single lights placed upon mast-arms at the intersections of the streets and elsewhere.

IT is stated that 90 per cent. of the vessels traversing the Suez canal go through at night by the aid of the electric light.

ONE of the most interesting historic exhibits relating to electricity, at the World's Fair, is the original working model with which Morse demonstrated the practicability of his telegraph, in a room in the University of the City of New York,

on Washington square, in 1837. It will be remembered that Morse was an artist by profession, and this model, crudely constructed by his own hands,—for he was no mechanic,—is made of a canvas frame or stretcher, to which is affixed the wheel-work of an old wooden clock for moving the paper, and a common lead-pencil, moved back and forth by a rude electro-magnet for registering upon it the arbitrary signs. When in use, the apparatus was nailed in an upright position to a common kitchen-table. Few who see this machine will be able to guess what it is, without other than intrinsic evidence. It forms a portion of the exhibit of the Western Union Telegraph Company.

A TELEPHONIC circuit for transmitting music, dialogues, etc., from concerts and theaters is in use in Paris, and is said to have more than fifteen hundred regular subscribers. A similar system is about to be introduced in London.

THE city of Stockholm, Sweden, has one of the best systems of telephonic communication anywhere in use. There is one subscriber to every twenty-eight inhabitants, while the annual charge is only the equivalent of $25 of our money. This result has only been rendered possible by the use of a twin-wire system, together with the most modern and improved appliances of all kinds, and the strictest economy in capital expenditure and in operating expenses. The wages of the employés are of course very small. It is estimated that a telephonic system capable of giving thoroughly efficient service can now be established in European cities for less than $100 per subscriber.

THE Pennsylvania Railroad Company have established a long-distance telephone system for the exclusive use of their principal officials, an improvement which is expected not only to secure a greater degree of privacy in communications, but to avoid the necessity of a great deal of tiresome, expensive, and time-consuming travel. The system will be extended south to Washington, and west to Chicago and St. Louis, bringing these and intermediate points into direct connection with New York, Philadelphia, and Altoona.

A REPORT on a set of storage batteries in a private installation, recently made by Professor Weber of Zurich, shows that it is possible, under proper conditions, to attain very favorable results. He found the ampere-hour efficiency of the installation to be 96.5 per cent. and the watt efficiency 82.4 per cent. He gives it as his opinion, after a very extensive experience, that well-constructed, well-managed, and continually active storage batteries will yield on discharge from 92 to 97 per cent. in ampere hours and 80 to 84 per cent. in watt hours. Other investigators have discovered that it is of the highest importance to use both pure water and pure sulphuric acid, and that the slightest impurity has a very great effect on the efficiency of batteries. This is a fact well known to many old telegraph men from their experience with primary batteries used in that service; the writer remembers an instance at Greensburg, Pennsylvania, in which he found it absolutely impossible to maintain a battery in working order which was made up with water taken from a creek in the neighborhood, although upon substituting rain-water, the difficulty vanished at once.

AT a recent soirée of the Royal Society specimens of electrolytic copper were shown by J. W. Swan, exceedingly hard and having a brilliant polished surface like a mirror, which had deposited under a current density of no less than 144 amperes per square foot. This extraordinary result is said to have been attained merely by the addition of a small quantity of colloid matter, such as gelatine boiled in nitric acid, to the ordinary acidulated solution of sulphate of copper. The process is carried out at a temperature of 15° to 20° C., and the current is applied intermittently, 15 seconds on and 15 seconds off, alternately, to prevent the formating of an insulating coating of gelatine. Sheets were shown as thin as paper; they had been stripped from the matrix of bright copper, and were exceedingly elastic, while their surface brilliancy is said to have been

marvelous. The same process has been successfully applied to the electro-deposition of nickel, with such excellent results that it seems not unlikely that the scratch-brush and burnisher may hereafter be wholly dispensed with.

AN electric company operating in Portland, Oregon, has arranged a plant for transmitting power from the falls of the Willamette, twelve miles distant, upon a different plan from that usually adopted. Five 40-kilowatt transformers are connected in series at the power-station with a dynamo giving an electromotive force of 1150 volts, which is run at such a speed that the current goes to line with a voltage of 5000. At the sub-station in Portland the voltage is about 4000, and the current is taken off by four similar transformers, also arranged in series.

A SOMEWHAT extensive plant has been erected near Brewster's, New York, where experiments are being conducted with an electro-chemical process of treating sewage. Two vats are employed, in one of which chemicals are mixed with the liquid refuse, which is then conveyed to the other vat, in which movable electrodes agitate the mass and at the same time pass a current from a dynamo-electric machine through it. This produces a violent effervescence, and is claimed to deodorize and disinfect the offensive accumulations. The process appears to be effective, while it has the advantage of being very inexpensive compared with most of the purely chemical systems heretofore in use.

IN the construction of astatic galvanometers and other instruments requiring the delicate suspension of a magnetic needle or system of needles, the cocoon silk formerly used has been almost entirely superseded by fibers of quartz. When properly treated, this material is capable of being drawn into threads of any desired thinness; while in respect to tensile strength, permanence, and freedom from elastic fatigue it is immeasurably superior to any substance which has been tried. Quartz crystals are fused in the oxyhydrogen flame, and the fused material is then drawn out into a rod one-eighth inch thick; this is redrawn by the ingenious method of shooting an arrow into a target from an elastic projector; the arrow is released by a trigger, and carries one end of the quartz thread with it. The thickness of the resulting fiber depends upon the viscidity of the molten quartz and upon the speed and range of the arrow, all of which may be readily regulated at pleasure.

THE decision of Judge Cox of the United States Circuit Court, pronouncing invalid the Faure patent for pasted plates for storage battery cells, will apparently have the effect, if sustained by the Court of Appeals, of substantially terminating the tedious legal controversy in respect to patents which has had such an injurious and depressing effect upon the storage battery industry in this country. The decision practically leaves the owners of the Brush patents in possession of the field so far as pasted plates are concerned.

THE tendency toward the employment of multipolar generators and direct-coupled steam-engines in all large installations is manifestly increasing. By diminishing the armature speed of the dynamo the electrical engineer appears to at last have reached a point where the steam-engineer can meet him under favorable conditions.

IT is suggested by Professor Francis B. Crocker that the thermo-electric couple is by no means so unpromising a subject for further investigation as a possible source of electric energy as usually supposed. Although its efficiency is low,—not more than 2 per cent. at the best,—the simplicity and directness of the operation would seem to render it admirably adapted to the requirements of small isolated plants. Professor Crocker expresses the opinion that, if the same amount of time, money, and scientific ability had been expended upon it that has been expended upon the storage-battery, the thermo-battery would long ere this have been available for many industrial purposes.

IT is much to be hoped that the Electrical Congress at the World's Fair, which will, in all probability, have completed its labors before these lines reach the eye of the reader, will formulate some authoritative definition of the illuminating capacity of arc lamps in terms of voltage and current. The hitherto accepted rating by "nominal" candle-power has no definite meaning whatever, and has given rise to numberless vexatious disputes between municipalities and electric lighting companies. Such an absurdity as this should no longer be tolerated in the present advanced state of electrical science.

MORE than 21,000 patents were granted on inventions involving the industrial application of electricity, between January 1, 1876, and December 31, 1892, and the number of new ones is increasing at the rate of more than 2000 per annum. This annual increase, by the way, is greater than the whole number of patents of this class which were granted from the establishment of the Patent Office down to 1876.

ACCORDING to the Board of Trade returns, the total output of electricity from all the central stations in London, as computed from the meter readings for the last fiscal year, is equivalent to 7,915,746 kilowatt hours, an increase of 84 per cent. over the preceding year. The cost of coal per kilowatt-hour varies in the different stations according to the returns, from a maximum of 4.72 cents to a minimum of 1.84 cents, being apparently, as a rule, greater in the stations employing alternating methods of distribution than in those making use of the direct methods.

A SYSTEM of telephonic control has been established in connection with the street-railway system of Denver, Colorado, which comprises 74 miles of track operated by electricity and 13 miles by cable. The telephone circuits are arranged with various call stations at the termini and junction points of the different routes, all in communication with the dispatcher's office at headquarters. Each conductor is required to report the time of arrival of his car at the end of its outward run, and is informed in return as to his proper time for leaving, and is at the same time given any other instructions which may be necessary. The expense of maintaining a "starter" at these points is thus saved, while a knowledge by the dispatcher of the whereabouts of each car at any particular time greatly facilitates the running of the system in case of the occurrence of a blockade from any cause.

THE returns for the year 1892-93 show a gratifying progress in electrical matters in the city of Berlin. The number of incandescent lamps has increased from 87,763 to 105,094; of arc lamps from 4516 to 5405; and of motors from 430 horse power to 800 horse power. The total output of current for all purposes has risen from 45,990,000 to 53,000,000 ampere hours. The use of motors is said to be rapidly increasing.

THE plant of the Pittsburgh Reduction Company, who have been for some years engaged in the manufacture of aluminum by the Hall process of electric smelting, is being removed to Niagara Falls, where it is to be reëstablished upon a much larger scale. In this process the cost of power is the principal item of expense.

ELECTRIC motors for opening and closing the gates are being applied to the locks on some of the Canadian canals. The power for operating the dynamos is derived from the surplus water at the lock. The new lock of the Canadian canal at Sault Ste. Marie is to be equipped in this way.

A PROCESS of manufacturing varnish from linseed-oil by the action of an electric current has been discovered in Germany, and is said to give remarkably good results.

AN English firm is constructing an engine of 650 horse-power for driving a dynamo for electric lighting. With the cheap gas used it is claimed that the consumption of coal is less than one pound per horse-power hour.

MECHANICS

Conducted by Leicester Allen.

IN type-setting machinery the application of mechanics to the art of printing is reaching a culmination. It is stated that during the last twenty years upwards of $9,000,000 have been expended in bringing the art of setting types by machinery up to its present state. Now, for all plain work, type-setting machines are available. In the London *Times* office a curious arrangement has been adopted for the composition of the stenographic notes of the Parliamentary reporters in the House of Commons, in which type-setting machines play an important part. The stenographic notes are read directly to the operators of the machines, instead of being transcribed, as was formerly the case. Men at telephones in the House of Commons read these notes to men stationed at receivers in the *Times* composing-rooms, who in turn read them to the type-setters. In this way these notes can be set up in type almost as rapidly as they could be transcribed by an expert type-writer; and it is said that the number of errors that creep in are not so numerous as to make the work of correcting proof much greater than by the old system, while a considerable saving in time and expense is effected.

THE straightest thing in nature or art is a ray of light when passing through a medium of uniform density. Hence the eye is enabled to test the straightness of an edge or tube by holding it as nearly as possible coincident with a ray of light, such parts as depart from straightness then intercepting the ray and causing a shade to be cast upon other parts. It is not known at what early period in the history of mankind the discovery was made that straightness could be thus determined. It is certain that thousands of mechanics use the method daily without being able to give a rational explanation of it. This primitive mode of testing straightness, on account of its great convenience and accuracy, is likely to continue in use to the end of the world.

THE recent test of the 12-inch nickel-steel armor-plate at Bethlehem, Pa., by Commodore Sampson of the United States Bureau of Ordnance, was a striking example, not only of the enormous resistance to rupturing stress in steel plates reached by modern metallurgic methods, but also of the tremendous energy developed by modern projectiles through the use of improved explosives. The plate was completely penetrated by a 250-pound Holtzer projectile thrown by a charge of 110 pounds of powder, which pulverized the projectile into small fragments upon its impact with the target. The velocity of the projectile at the instant of striking was 2005 feet per second. To gain a better conception of the tremendous energy represented by these figures they may be reduced to terms of work in foot-pounds. Thus, a projectile of the weight named, moving at the velocity stated, has stored up in it a potential energy competent to the performance of 4,396,910 foot-pounds, or 2198.455 foot-tons. Referring this energy to the weight of the explosive, we find that a pound of the latter must have contained an energy representative of 19.985 foot-tons, or one ounce would represent 1,249 foot-tons. A single grain of the explosive is equal to the performance of 357 foot-pounds of work. These estimates are for net work after deducting losses for windage, friction, and resistance of the air.

THE new anti-friction composition, which has been noticed once in this department under the name of "carboid," continues to attract the attention of mechanical constructors in Europe, and the English engineer, Mr. Killingworth W. Hedges,

its inventor, has recently been in this country bringing it to the attention of American manufacturers. He undoubtedly has had to encounter some prejudice due to failures that attended the attempt to introduce a material for which similar claims were made some years ago in the United States under the name of "metalloid." It was claimed for the latter material that it had a lower coefficient of friction without oil or other lubricant than metal bearings lubricated with a good quality of oil. These claims could not be substantiated. The writer once gave a challenge to its promoters to subject the material to the usual approved method of determining coefficients of friction, in comparison with metals then commonly used for bearings, but it was not accepted. Notwithstanding this material failed to meet approval from American mechanics, it did not lack the aid of statements and testimonials from authoritative sources that it was all it claimed to be. Similarly, carboid has the support of high authority for its claims, which, however, are not so extravagant as those that were made for metalloid. Professor Unwin, who has given these claims attention, while not asserting that the coefficient of friction is less than that of well-lubricated metal bearings, yet appears to believe that, for many uses, a material that can be used for dry bearings with as little friction as carboid will be a valuable acquisition to our present stock of anti-friction materials. Among the applications named for which such a material would be especially valuable is included the manufacture of explosives—dynamite, for example—wherein the machinery has to be left working by itself for a period of time limited by the necessity of oiling, which limit would not exist if carboid or other oilless bearings were employed. The composition of carboid is graphite and steatite powerfully compressed, and subsequently baked, the mixture so prepared being amenable to ordinary tools used for working metals, so that it can be planed, turned in a lathe, or otherwise fitted as desired.

IT is interesting to note how frequently mechanical ideas revert to abandoned principles, resuscitating them and rehabilitating them. An example of this is found in a car-brake for use on either steam or electric roads, recently announced as the invention of a mechanic in Cohoes, N. Y. The principle of this brake is precisely the same as that of the brake-shoe long in use by wagoners for holding back loaded wagons in descending steep declivities. Hitherto the application of this principle to braking railway-cars has not been successful, although it works perfectly at low speeds, and it may be that the inventor of this brake has been able to obviate the disabilities of the ancient brake-shoe.

EFFORTS aimed at the prevention of rust in iron work exposed to the action of air and moisture have resulted in the invention of several processes more or less effective for the purpose. It has been found that the formation of a coating of magnetic oxid is, under many circumstances, a considerable protection against the formation of the sesquioxid which is what is commonly called iron rust. The protecting oxid is formed when iron is exposed for a sufficient length of time to the action of highly superheated steam. The renaissance of art in wrought-iron work now in active development in the United States renders any process that will afford more ample protection of special importance at this time. A large establishment has been organized in the city of Brooklyn, N. Y., for the purpose of rust-proofing under what is called the Gesner patent process. This process differs radically from any other that has preceded it. Instead of substituting one oxid as a protection against the formation of another, this process is claimed to transform the surface into a peculiar combination of carbon, iron, and hydrogen, which is permanently proof against the action of air and moisture. Some other peculiar claims are made for this process. It is stated that it renders the metal treated by it capable of remaining proof against rust when exposed to the action of sea-water, earth, or steam condensing upon the surface, the latter being, as is well known, a most effective

agent in corroding polished surfaces. It is claimed, in addition, for this new process that it does not increase the dimensions of the article treated, and that the iron is strengthened rather than weakened by the treatment. In fact, some extraordinary claims for increase of strength have been published which it is preferred to not repeat until further opportunity is afforded for their verification.

STILL another method of preserving iron, which is equally applicable to zinc and copper, as well as alloys of the two latter metals, introduced by M. Ghest, of Paris, France, is attracting attention in Europe. The preservation is accomplished by the application of a new composition, which is spread upon the surface by the use of a brush like ordinary paint, and which may be made the basis for subsequent coats of any of the common paints. Thus, after the protective composition is applied, the surface may be ornamented by painting and gilding in the same manner as heretofore. The formula for this composition has not been made public; but the accounts of its properties indicate that, while its preservative action is extraordinary, rendering the metals proof against the action of the strongest acids, it has remarkable flexibility and elasticity, so that metal sheets covered with it may be bent, twisted, or torn asunder, without cracking the coating except at the part where the metal divides. It is said that a brass sheet to which this composition had been applied was subjected to the severe test of first being placed in a sewer for three months, and then being placed in a bath of strong nitric acid, without any perceptible action either upon the metal itself or upon the composition.

STILL yet another process for rust-proofing iron has been invented by Pierre Henry Bertrand of Paris, France, which has for its object the production of a coating of permanent magnetic oxid upon the surface, as in the Bower-Barff process. In this process the oxid is formed by volatilizing a thin layer of volatilizable metal or alloy with which the metal has been previously coated. The coating of the iron to be thus protected by the volatilizable metal is performed by dipping the articles to be treated in baths of solutions of the salts of the coating metals. The protective coating of magnetic oxid is then very easily formed by exposing the articles for about ten minutes in an inclosure heated to 1000° C., and to which air is freely admitted. The rationale of this process, as explained by M. Bertrand, is that the layer of volatilizable metal obstructs the free action of the oxygen in the heated inclosure upon the iron surfaces, the result, instead of being the sesquioxid or common iron rust, being the magnetic oxid. A notable claim made for this process is that it may be followed by enamelling, thus producing very much more durable enamelled ware than has been hitherto possible. In this way, for a period of some two years, the inventor has been manufacturing articles which are claimed to be absolutely non-conductors of electricity; and *The Iron Age*, from which the principal facts in this note have been derived, also states that the process has been successfully applied to cooking utensils, soil-pipes, railings, stable fittings, gas- and water-pipes; the process being cheap, and the time necessary for forming the magnetic oxid and performing the enamelling being less than one hour. Samples of articles thus protected are on exhibition in the French section of the Electricity building at the World's Fair in Chicago.

SINCE the invention of the Globe valve by Nason, the pioneer in the art of steam-heating, many have been the attempts to supersede this beautiful and ingenious device and to improve it. It has been greatly improved since its first introduction, but so far all attempts to supersede it except for some special purposes have failed. Still, among the inventions sought to be patented, improvements in valves form a numerous class. That this is the case is ample evidence that there are faults in all kinds of valves used for controlling flow of fluids through pipes which annoy their users. In properly-constructed globe-valves or gate-valves there need be very

little of this kind of annoyance. The trouble lies mostly in the efforts of manufacturers to cheapen valves beyond a point at which a really good valve can be produced. In a large line of globe-valves now on the market there is not sufficient metal to endure the usage to which they are subjected. The seats are so light that they will not withstand the pressure of the screw on their stems when closing them. It is true that it is unnecessary to screw down the disks with great force when the latter are well fitted to their seats. But the fitting is not always perfect, and sometimes dirt or other obstruction prevents perfect closing; and in such cases careless people are wont to screw down the disks with all their force with the intent to close the valve tightly. The result is that the valve-seat is sprung, and until refitted is permanently disabled. Thousands of valves in use, in steam-heating apparatus and in pipes used for other purposes, may be found leaking more or less from this single cause. It is not a sufficient justification on the part of manufacturers to say that they have performed their duty when they have made valves strong enough to just withstand the most skillful manipulation. Valves should be made strong enough to endure the treatment they will inevitably receive, and not merely that which in strictness they ought to get. It is one of the unavoidable contingencies in this class of devices that the majority of them go into the hands of the unskilled and careless.

THE largest power-hammer ever constructed is undoubtedly that of the Bethlehem Iron Company, at South Bethlehem, Pa. The combined weight of the piston, piston-rod, and tup of this mammoth hammer aggregates 125 tons. In a recent issue *The Iron Age* devoted a number of pages to an illustrated description of this magnificent example of mechanical engineering, from which the weights and dimensions are condensed as follows: The foundation for the anvil is constructed in a pit at the bottom of which piles 35 to 40 feet long were driven at intervals of from 2½ to 3 feet. Alternate layers of planking and wood shavings laid upon the tops of the piles support a course of heavy iron blocks. Upon the top of this course is laid a course of planking with intervening cork nailed to the planks, the thickness of this course being 18 inches. Upon this a course of steel bars is laid. Then there is another course of plank and oak, succeeded by a course of heavy cast iron blocks; then more layers of plank and cork; and, lastly, six courses of cast-iron blocks. The estimated weight of metal in the anvil blocks is estimated at 2150 tons. The machine stands 90 feet in height above the surface of the ground, and its total width is 38 feet. These grand proportions may be better appreciated by imagining it to stand in front of a country church of average size, in which position it would hide nearly the whole of the front of the building, and would reach nearly or quite to the top of the steeple.

It is interesting to consider the power that could be delivered by a single stroke of this great hammer. By its own weight, unassisted by the pressure of steam, it could deliver considerably more than 2000 foot-tons, as the stroke is 16 feet and 4 inches. But as the area of the piston is 4536.47 inches, and as steam is carried at 120 pounds per square inch, the pressure upon the piston will be upwards of 272 tons; and if steam be admitted full stroke, the work represented by the steam-pressure would be nearly 4461 tons, making the total work which would be represented by the hammer at its maximum over 6460 foot-tons. In other words, a single blow of this hammer would represent work sufficient to lift a large ship and her cargo one foot in height.

AN interesting display at the World's Columbian Exposition is made by the Consolidated Car Heating Company (Albany, N. Y.), consisting of a model locomotive and train of three passenger cars, the cars being fitted out with the systems of steam heating which this company is now supplying. Everything in this model is completely representative of modern railway progress. The locomotive and tender, aggregating six feet in length, form a working model which is operated by compressed air, for which steam could be

substituted if desired, and the cars are fitted up in the most modern style and lighted by miniature electric lamps. Each of the cars is eight feet long, and the total length of the miniature train, including the locomotive, is thirty feet.

AN interesting book might be written on the subject of "Evolution in Mechanical Construction," and, should such a book ever be produced, one of its most interesting chapters will treat of the gradual growth into perfect form of some of the most common articles and utensils in daily use among civilized men. Take, for instance, the common barrel or cask for containing liquids. It is evidently a modification of a cylindrical vessel, tub, or tank, probably, in its first form, a length sawed off from the trunk of a hollow tree, and having one end plugged to form a containing cavity when the rude utensil was set up on the plugged end. In oriental domestic use we find this prototype still extant, the hollow trunks of large bamboos forming the cylindrical inclosure. How long it took, after the first resort to this device, for its contrivers to learn that both ends might be plugged and the liquid introduced through a hole in the side and retained there by a third plug driven into the bunghole, is of course impossible to imagine; but centuries probably elapsed before even this advance was made. Then some one had the ingenuity to conceive the idea of constructing a tube of wooden staves bound together by hoops. In the development of this idea, making the tub smaller at one end than at the other in order that the hoops might bind without driving wedges under them probably did not dawn upon the mind of the primitive cooper till the lapse of more centuries. After this the idea of making it smaller at both ends than in the middle and inserting heads in both ends had to be incubated; and this very likely took more centuries. Now consider the result of all this slow growth. The form of an oblate spheroid thus evolved from the plugged bamboo is the most convenient possible for the handling of such substances as are usually put in casks. A well proportioned cask may be turned over endwise—a movement often required—almost as easily as it can be rolled along on its side. And when it is set on end it has a firm base to stand upon,—a great convenience in storing and in transportation. It is light and strong, rivaling in strength almost any other structure of equal weight that can be compared with it. The chine also supplies a most convenient means for grasping with the hands and for attaching appliances for hoisting. In this familiar article we have an example of evolution in mechanical construction that has apparently reached its limit, since no radical change in its general form has been made in it for more than two centuries.

IT is well known that the construction of the marine boiler is not favorable to satisfactory circulation of the water in it, by means of which it can be maintained in all parts at the same temperature. The lower parts get several degrees colder than the parts which are over the furnaces, and the colder and heavier water remains there without being stirred up to mix with the lighter and hotter water from which the steam is escaping at the higher level. The consequence of this inequality of temperature is a series of strains upon the shell, which are particularly trying and create a liability to leak at the seams. This leakage is the first step towards that corrosion which is always an element of danger, and which it is desirable to prevent if it is in any way possible. This difficulty gives especial interest to a form of water-heater which is being experimented with at Liverpool, the principal feature of which is that the suction of the feed-pump is taken partly from the hot well of the engine where it has a temperature of 110° to 130°, and partly from the lower part of the boiler under the furnaces. Of course the latter water will be at a temperature higher than 212°, and by suitably adjusting the proportions the water which passes out through the delivery-pipe can be brought up to that temperature. By this means the water in the boiler is compelled to a circulation to supply the place of that withdrawn.

ARCHITECTURE.

Conducted by Barr Ferree.

THE time for the presentation of drawings for the municipal building competition in New York closes on this date, and the hundreds of architects, draftsmen, and students who are supposed to have entered for it will now find time to think of other things. It is simply appalling to contemplate the brain-work these people have performed during the last few months, when in the nature of the case the competitors are for the most part doomed to disappointment. Only six prizes are offered, and, if three or four hundred architects compete, a very simple arithmetical calculation will enable the reader to correctly estimate the number of disappointed ones. While it is scarcely possible that so large a number of drawings will be sent in, it is authoritatively stated that more than five hundred copies of the book of instructions were called for. There is, therefore, every reason to look for an enormous number of drawings, and we respectfully tender our sympathies to the committee that will have to pass on them. The architectural schools have of late years turned out a large number of would-be architects, and this competition has presented an unrivaled opportunity for the best of them to advertise themselves if, by great good fortune, they should secure a prize. It is from these young men, rather than from the older architects, that the most elaborate designs may be looked for. Not that the older men are likely to view the matter with indifference, but the younger element have had larger opportunities to think about the problem at hand, and, coming fresh from the schools, their work is likely to be more *Ecole* in character—and perhaps more impossible in construction—than the work of more matured minds. As to the relative character of the designs that will be offered, it is, of course, impossible to speculate. One or two recent competitions, notably that of the Brooklyn Museum, quite failed to bring out the talent it was hoped would be manifested, and in that competition it was not the best design which succeeded. But at least it is safe to say that our architects and young men—for fresh graduates must necessarily be placed in a class apart from architects who have been practising for years,—have done the best they could. New York ought to have a splendid municipal building, and the prizes have been large enough to attract the very best talent, while the first prize, the building itself, is something the busiest architect may well covet. It may, however, be questioned if the busiest architect is the best man for a building of this kind. A youth fresh from the drawing-class is obviously incompetent, be his design as fine as it may. The building of such a structure necessitates knowledge and experience that is not gained in a four years' course in an architectural school. But the final decision, it should be remembered, rests with the board of building commissioners, not with the judges. The latter make their report, and designate what they consider the order of merit of the drawings, but the final decision is with the city authorities.

THE exhibit of woods contained in the Forestry building is one of the most interesting collections at the World's Fair. The exhibit of woods is extremely fine, and no building compensates one better for a day's study than this somewhat remote and neglected structure. The collections represent wood in all its phases, though perhaps rather more from a forestry standpoint than any other, but the general public, as well as the specialist in woods, and especially the architect, cannot but be interested in the beautiful and complete displays made. It is only of its architectural interests we have occasion to speak, but the general bearing of the collections

should not be overlooked. The contents of this building are notable in forming one of the few complete displays in the exposition. The woods are shown by countries and by States,—most of the timber-bearing States being well represented, and the foreign exhibits including Japan, Mexico, Argentina, New South Wales, France, and other countries. The foreign displays are not especially noticeable, most of them being small in extent, and the majority of woods being tropical or ornamental species not obtainable in this country. Of these special mention may be made of some very fine boards, having an exquisite polish, from New South Wales. These are of great size, and, if obtainable in marketable quantities at fair prices, should be excellent for interior work. A beautiful purple wood from Trinidad—the "purple heart"—should also be mentioned as among the most striking specimens shown. But the displays of native woods are more interesting. First of all, they are very complete, being supplied with ample labels, and shown in sections and finished with polish. The New York display, supplemented with transparencies and large photographs of trees in their native state, is especially notable, though similar photographs are shown by other States. Several States also show practical examples of their wood products as applied to buildings in manufactured products, screens, doors, panels, counters, etc., all arranged with good taste and showing the varied woods of the States to the best advantage. One or two private firms likewise exhibit finished products, the Southern Lumber Manufacturing Co., for example, having large rooms wholly finished in wood. The great merit of the collections in the Forestry building is their completeness, both as to variety of exhibits and for the ample information given the public. It is one of the few buildings in which any one, whether familiar with the subject or not, may really learn something from examining the exhibits, and that without having to trouble an attendant with questions. This is a tremendous advantage, and it is so exceptional as to call for special comment. The chief of the department and his assistants, as well as the individual exhibitors, are to be congratulated for the thoroughness with which they have performed their task.

It is a matter of more than ordinary regret that the same care was not taken with the other departments allied to architecture. For the present we are only concerned with the architectural collections at the Fair, and hence look at it through architectural spectacles. The department of building materials is one of which much might have been expected, in which the individual exhibits make a goodly number collectively, and of which information is as hard to get as a Philadelphia spring chicken in the lanes and cowpaths of that rural city. At first thought, perhaps, no architect would think of looking for anything that concerned him professionally in the Mines and Mining building, and perhaps this is one reason why the larger part of the exhibits of building stones, clays, and the like, were put there. Whatever the reason, there they are, and, if one would care to see a nice lot of stones, carefully labelled, in most instances, with their name and place of origin, no better place to examine such a display could be imagined. The collection, taken as a whole, is a fairly large one. As usual, the foreign exhibits are practically *nil*, and the honor of making the major part of the display therefore rests upon the United States. Neglecting the foreign collections altogether, the exhibits may be roughly divided into two groups, those made by the States and Territories, as part of their State exhibits, and the collection made under the direction of the department of Mines and Mining, and which is located in one of the galleries of that building. The latter may be considered first, for, when its origin is taken into account, it might naturally be supposed to be the most valuable. And so it doubtless is, since the specimens are arranged with great care and nicety, and each is distinctly marked with its place of origin and its name. This is very well as far as it goes, but the inquiring architect who may wish to find out something about these stones, who

may wish to compare the similar products of different vicinities with a view to preferring one stone to another, in a word, one who wishes to find out anything about the structure of the stones, their power of resistance, wearing qualities, and the like, all of which are of vastly more practical value than the common or scientific name, will find it quite impossible to gain any knowledge, either from the specimens themselves or from the chief of the department. The collection is simply a nicely arranged collection of cubes of various colored stones, pretty to look at, of some value, perhaps, to a college, where they could be handled and studied, and where their properties could be ascertained, but absolutely worthless as illustrations of the resources of this country in building stones.

DOWN-STAIRS, on the main floor, things are not much better. The collections here are in the charge of the different States, and, if one's intellect can survive the sight of the horrible silver statue that is placed in the center of the Montana exhibit,—and which, by the way, is the center of a vast crowd every day, though the horrors of this silver image is apt to be forgotten in its monetary value,—one may see a tolerably large collection of building stones. But information is no freer on the main floor than on the gallery; in fact, things are, if anything, a little worse, since the very attendants here glory in their ignorance. Several States make very good shows. New York is one of these, the collection being large and fine, generally well arranged, but without any structural information. Pennsylvania likewise has quite a collection, even less instructive than that of its great neighbor's. One or two States have enclosed their displays in pavilions built from their own building-stones, a very good idea, though such an arrangement would have been more satisfactory in the open air. In this respect Ohio, which has a large collection at Chicago, made a better showing at Philadelphia, where an entire house, built of various Ohio building-stones, was erected on the grounds. There is, therefore, very little to chronicle in connection with this display, save to regret that it had not been made of greater educational and practical value, and been really useful to the architect and builder, as it was, in idea, intended to be. The entries in the catalogue, coming under this head, make a formidable showing, but, while it would be grossly unfair to say that every stone has been catalogued, the difference in volume between the actual exhibits and the space in the catalogue forcibly impresses one.

THOUGH the display of foreign building materials and appliances of any sort is extremely limited in the Mines and Mining building, some few exhibits belonging to this department may be seen in the Manufactures and Liberal Arts building. As might be expected, most of these collections consist of ornamental stones and marbles. New South Wales is an exception in this respect, her exhibits including not only marbles and costly stones, but the more common sorts of granites, sandstones, and the like. This collection is rather more valuable as illustrative of the resources of the colony than it is likely to be as a stimulant of importation into this country. The United States is so amply provided with building-stones of the more ordinary kind that we do not need to look to Australia for such materials. But the fullness of the collection from New South Wales deserves commendation, not only because it is the only British colony making any attempt at a serious display at the Fair, but because it indicates a very commendable industry and energy. A notable part of this display consists of blocks of marble, taken from various quarries, and shown in blocks of good size. These quarries have not yet been much worked, and hence the samples shown, we are informed, do not represent the best grades that can be obtained from them. But even as they stand the range of colors—pink, white, black and white—is fairly good. Next to these, perhaps surpassing them in interest and in beauty of arrangement, is the display of marbles made by the Société Anonyme Merbes-le-Château, of Belgium, which make a very

fine display, beautifully arranged in panels of equal size, of marbles of the most varied colors. Though this collection occupies only a relatively small amount of wall space, it is well worth looking at. The Belgium section also shows some small collections of black marble of fine surface. Few other countries make any contributions to this department, scarcely more than a single collection or group of stones being attempted in any case. Mention might be made of the pyramid of marbles of various colors shown by Chr. Anker, Fredrikshald, Norway, and of the collection of syenite granites by Erik and Gude, of Christiana, Norway, of which an "emerald and blue-pearl" variety is the most striking.

THE ornamental side of architectural construction as represented in materials is not very well shown at the Fair. Quite a number of firms, both foreign and American, make exhibits of tiles, and the volume of these is quite considerable. The most satisfactory thing in connection with these collections is the very marked and evident progress our own manufacturers have made since the Philadelphia Centennial. There are many other departments, of course, in which the same satisfactory comparisons may be made, but this is one of the most notable advances in artistic progress in this country. Tiles, and chiefly decorative tiles, are the most important contributions to the building art made by foreign exhibitors. Several well-known English firms are well represented, and the average quality of the displays is generally good. In France the most important exhibit in this collection is that made by Emile Muller et Cie., of Ivry-Port, near Paris. This firm shows a large collection of architectural work in faience and stoneware, arranged with the taste and skill of which the French are most eminent masters. A large part of this exhibit consists of a reproduction of the famous "Archers' Frieze" from Susa, Persia, now in the museum of the Louvre. This is one of the most splendid pieces of ancient tile work that has survived to modern times, and, while the present reproduction is scarcely likely to have any special commercial value, it serves excellently well for displaying the resources and ability of the Muller products. More striking than either the French or English display of tiles is that of Germany. This is due to two causes, first, because much of it is hopelessly bad, and, secondly, because a large portion of the display is on the main aisle, where its brilliant coloring and prominent position ensure universal attention. The most objectionable part of this display, and it is more extensive than that of either England or France, consists of series of large tile pictures, the subjects of which vary from the allegorical to the historical. The most that can be said in favor of these things is that they form an effective background for the displays of china and porcelain placed in front of them, but they are without any artistic value, and quite useless to the architect.

THE most important architectural event of the past month was the holding of the International Congress of Architects at Chicago. Rather it should have been the most important event. As it was, it was only rescued from completest failure by the energy of the president and secretary of the American Institute of Architects, who merged their own splendid program of papers and addresses into the proceedings of the Congress. By this means the latter body assumed an appearance of respectability and energy to which the labors of the committee having it in charge contributed practically nothing. After more than a year's work this body only produced eight papers, three of which were by American contributors. We do not hesitate to refer to this failure, since with properly directed energy the International Congress might have been made successful without the help of the Institute. The whole matter properly belonged to the latter body, but, an independent organization having assumed charge of it, it should have carried its work through to the end. The first week in August was not a good season at which to hold the Congress, though the Engineering Congresses, held at the same time, were, as is

the case with all public meetings of engineering societies, completely successful. August is not the best time in the year to visit Chicago, and many architects, especially the younger ones, were busy completing their plans for the new municipal building competition in New York. This enterprise has just closed, and the first week in September is likely to see more architects in Chicago than were assembled in that city during the first week in August.

THE Department of Architecture is extremely glad to tender its heartiest congratulations to the American Institute of Architects, and especially to President Kendall and Secretary Stone, for the very interesting and extended program they procured for the convention of the Institute, and which, through their courtesy, become the larger part of the proceedings of the Congress of Architects. This generosity in thus giving away the largest and most varied program ever presented by the Institute deserves the heartfelt thanks of all architects as well as of the more general public that takes an interest in this great art. The Institute programs have been so usually devoid of interest in the past, the value of the meetings and of the interchange of professional intercourse has been so little understood and appreciated by the profession, that this new departure by the Institute, for which Mr. Stone is chiefly responsible, is the more satisfactory and the more to be commended. The papers read at the Congress covered a wide variety of subjects. The most notable were unquestionably a group of papers prepared by the architects and engineers of the Exposition, giving for the first time an authoritative and professional view of the organization of the Exposition and the work done by those responsible for it. Of the vast quantity of matter that has been written on this subject these papers are likely to remain the most valuable. The papers in this group covered all the more important architectural and engineering features of the Fair so far as the work of organization was concerned. The other papers, which comprised the larger part of the program, were also interesting and valuable, though not quite in the same way. The variety of subjects, as the printed program shows, was sufficiently large to interest almost every architect, and the range of papers indicated a most healthy diversity of thought among the members. Reference to some of the more important of these must be deferred to future issues of the Magazine; meanwhile we will content ourselves with expressing the hope that the literary activity manifested in the architectural profession, as indicated by the program of the recent Convention of the Institute, will mark the beginning of a new era of professional activity in that body, which will mean an increased usefulness to the members professionally as well as to the general public. The latter, in some respects, are more important than the architects, since without the public the architects could not find business to support life. Every step which widens the interest of the general public in architecture in any or all of its branches is a step forward in the practice and elevation of architectural art.

MINING AND METALLURGY.

Conducted by Albert Williams, Jr.

THE international Engineering Congress which assembled at Chicago on July 31 was a notable one. Prominent among its sections were division C of mining engineering and division D of metallurgical engineering, both being in charge of the American Institute of Mining Engineers. The list of papers read embraces many on important subjects by distinguished engineers. Among the representatives from foreign countries may be counted some of the best-known authorities in the mining and metallurgical professions, while of course the American members of the Institute turned out in great force to welcome their guests. These international gatherings of professional men, yearly becoming more frequent and better attended, are not only of considerable scientific and technical importance, but tend also to encourage the world-wide feeling of good-fellowship, mutual interest, and generous rivalry which ought to, and does, prevail. The whole tendency of the times is toward the freest interchange of information and opinion, a policy much more sensible and progressive as well as more liberal than that of keeping "trade secrets"; while the social features of these conclaves cannot be too highly esteemed.

IN a description of the Turkey Heaven gold district, Alabama, Mr. W. M. Brewer calls attention to a method of construction adopted in a small stamp-mill lately built there, in which the batteries are so placed as to have no direct connection with the floor and walls of the building, thus avoiding jarring and allowing of a lighter and cheaper construction of the latter, because there is no vibration to rack the framework. The plan is not new, but is seldom carried out to the fullest extent. All stamp-batteries have independent foundations, the mortar bed resting on heavy vertical timbers set like spiles, securely bound together and usually surfaced with some deadening material on which the mortar rests, while to still further ensure solidity sometimes special preparations, as melted sulphur, are run into the timber ends. But all this is of little avail to prevent outside vibration if the struts to the battery frame connect with the timbers of the building itself. Besides the question of independent stability of the batteries and the building, it is important that the other apparatus, especially that requiring nice adjustment, should be free from unnecessary vibration. Mr. Brewer also mentions a method used in hanging the lower ends of the plate frames by adjustable hooks, thus permitting a ready change in inclination of the plates. This, too, is a good idea.

THE export duty on bullion from the peninsula of Lower California was advanced on July 1 to $75 per $1000, or 7½ per cent. Formerly it was about 3 per cent. The Mexican policy of taxing exported bullion has certain practical reasons for existence, among them the convenience of collection; but it has a deterrent effect upon mining, and the increase in the present instance will be severely felt by the mining industry of the peninsula, which, in spite of the many good mines, has already had sufficient natural disadvantages to contend with.

A SMALL riot occurred at Leadville, Colorado, on August 3, caused by a horizontal reduction in wages at the Arkansas Valley smelting-works, one of the largest reduction plants in the West. Some of the men accepted the proposed terms and went on shift as usual, but were driven off by the dissatisfied ones, with threats and some actual violence. Then the works closed down. Everywhere retrenchment

is the order of the day. It is not the fault of the managers of mines and reduction-works that a considerable part of this retrenchment must fall upon labor, though there is a perverse feeling among many employés that the hard times are made an excuse for reducing wages. This idea is unwarranted. It is a matter of necessity, not choice, under present conditions.

ALL the silver-mining camps are full of idle men, most of whom have been thrown out of employment by the closing of the mines on account of the low prices for silver. In some cases, however, the men had a chance to continue work at reduced wages, $2.50 a day for miners being offered usually; but they almost invariably declined to accept the reduction, whereupon the employers, who might have continued operations had the men been willing to meet them half way, have closed their mines also. The result of this mistaken policy on the part of the miners is that thousands of them cannot now get employment at any wages whatever, and much perhaps unnecessary distress has been the consequence.

LAKE SUPERIOR iron-mines have suffered severely during the recent general depression in almost all industries, though less complaint has been heard of this than of the sudden decadence of silver-mining, and far less attention has been given it. In the various iron-ore districts collectively known as "the Lake" some large mines have been forced to suspend, at least until stocks on hand should be exhausted, and this too in the midst of the shipping season. The number of men thus thrown out of work was large.

THE jury of awards in the Mining department of the World's Columbian Exposition perfected its organization in the last week of July, with the following officers: President, Mr. Henry M. Howe, of Boston; vice-presidents, Messrs. de Zellenkoff, of Russia, and Lundbohm, of Stockholm; secretary, Mr. J. D. Weeks, of Pittsburg. Among the prominent names on this jury are those of Professors LeNeve Foster and Bauerman, of the Royal School of Mines, London; Signor Capacci, of Florence, Italy; Mr. Odelstjerna, of Sweden; Professor White, of the University of West Virginia; and others. The work of judging exhibits was begun at once.

THE mineral production of Great Britain in 1892 was in the aggregate lower than in 1891. Coal fell nearly 3,750,000 tons to 184,751,629 tons; iron ore, about 1,500,000 tons to 11,497,456; and most of the other mineral products, with the exception of zinc ore and a few minor minerals, declined proportionately. The foregoing quantities are stated in metric tons (2204 pounds). The list of minerals reported in the British statistics as of domestic production includes alum shale, arsenic, arsenical pyrites, barytes, bauxite, clays, coal, copper ore, copper precipitate, fluorspar, gold ore, gypsum, iron ore, iron pyrites, lead ore, manganese ore, ocher and umber, oil shales, phosphate of lime, salt, slates, sulphate of strontia, tin ore, wolfram, and zinc ore. Besides the many mineral products of home production, the United Kingdom imports largely from foreign sources; while it exports coal, salt, and a few other mineral substances.

CALIFORNIA gold-mines are now producing considerably over $1,000,000 a month; and the *Mining Press* (San Francisco) thinks that there is promise of a decided increase during the rest of the year. Since the cessation of silver mining elsewhere an impetus has been given to gold mining in California, as in other States and Territories, that is destined to augment the product. As the *Press* justly says, California has by far the largest and most productive gold-mining area in the United States. Good "running" gold-mines are comparatively scarce and are in demand. They are hard to find for purchase, as those who own them hold on to them. The *Press* thinks that the smaller claims and prospects are what will have to be taken up by investors in search of gold properties.

EFFORTS are being made to reduce ex-

penses in operating the mines of the Comstock lode, of Nevada. There has always been room for reduction of the office expenses of these mines. It is stated that the railroad and the water people have agree to cut down their charges, and the wood people, whose profits are small, have agreed to reduce as much to the mining companies as the railroad will reduce to them. The way the matter now stands, it depends upon the miners' union to meet all the other interests. A 25-per cent. cut in the salaries and wages all around was the proposition of the operators. Such large interests are at stake in the continuance of work on the Comstock—not only the direct investments in the mines and mills, but also those in the transportation, and the timber, fuel, water, and other supplies and adjunct industries—that every endeavor has been made to keep the mines going. It should be remembered that a large proportion of the total value of the product is in gold, that proportion increasing with the decline in the value of the silver.

THE number of men directly involved in the great strike of the English coal miners, which began toward the close of July, is stated at about 350,000. The English coal miners, like the miners in various districts of this country, chose a peculiar time to inaugurate a strike, just when the general business depression and the need for retrenchment in all directions were against them.

THE great decline in the market value of mining plant in Utah has caused the representatives of insurance companies to withdraw from the mining camps of that Territory, and, it is hinted, to curtail risks on mining property and in mining camps throughout the silver-producing region of the far West. The insurance companies are said to be refusing to renew policies, at least on the former terms.

NOT to be behind their comrades elsewhere, the miners working in the collieries of Nanaimo, British Columbia, lately went on strike. The cause was a proposed reduction of 20 per cent. in wages. Subsequently a compromise on a 10 per cent. reduction was effected.

RUSSIA'S gold production in 1892 was 38,822 kilograms, against 36,310 kilograms in 1891, showing an increase of 2512 kilograms. The 1892 output would be worth, in American money, $25,801,101. This gold comes from a number of widely separated districts, and not mainly from the Urals, as generally supposed. At present the Irkutsk district in eastern Siberia is the principal source.

THE name of a new corporation is the Woman's Gold Mining Company. It has $800,000 (nominal) capital. Its directors are all of the irresistible sex. The property is at Cripple Creek, Colorado. If the directors' meetings are to be frequent, and as animated as those of the board of lady managers of the World's Fair, there will be a sufficient outlet for the energy of the company to preclude the necessity of utilitarian earth-grubbing. There is a law against the employment of females (base word!) underground in mines. It does not specially forbid the descent of female superintendents or forewomen, certainly not of visiting lady directors. This is a new extension of woman's field of usefulness, the outcome of which will be watched with interest.

SEVERAL recent locations of borax claims have recently been made in the Calico mountains, in the arid region of southeastern California. They are said to be very rich and that samples run 75 per cent. of the salt. It is not generally understood how important the borax industry of California and Nevada is and has been. In resources and output it outranks all others in the world. The production is over 11,000,000 pounds annually, worth seven and a fraction cents a pound, spot.

NOT to excite the minds of possible investors, or boom the property by specifying the name and locality of a gold mine reporting an "extensive" strike of $100,000 ore are not here given. The best ore, in any

quantity, that the writer has ever seen ran about $300,000 a ton. There were perhaps a hundred pounds of it,—say $15,000 worth. The mine that produced it was offered for sale at $60,000, which means that, if it would yield just one solitary ton of similar ore in all its future history, it would return $240,000 gross to the buyer. In the present case it is quite likely that $100,000 gold ore was struck; that is, a nice little pocket-piece. But "extensive" is too much. A $30-a-ton gold mine of any size is a bonanza; and a big deposit, favorably situated, may run way below $5 a ton and be another Alaska-Treadwell or Homestake.

THE South American mining exposition will open March 15, 1894, at Santiago, Chile. It will be an exhibition of mining and metallurgical appliances, and should be taken advantage of by American manufacturers who are interested in the export of such machinery. The undertaking is in charge of the Sociedad de Fomento Fabril; and the secretary of that society, Señor Julio Perez Canto, at Santiago, may be applied to for information.

ACCORDING to the *Moniteur Industriel*, the engineers of the principal coal mines of the north, in France, are studying the application of aluminum to the manufacture of cages, cables, etc. The difference in weight between aluminum and iron and steel is considerable, and consequently the use of the former would increase the load capacity; on the other hand, the continuous lowering of the price of the metal renders its use possible. While it is possible that the use of aluminum as the material for certain mining apparatus or parts of apparatus is feasible, it is doubtful whether, in the present stage of aluminum metallurgy and manufacture, engineers would care to rely upon hoisting cables made of aluminum. Steel wire, either in round laid or flat woven cables, is an extremely reliable material, and one knows exactly what to expect of it; while in any event it will probably be a long time before aluminum manufacture has so advanced that the same reliance can be placed upon it. Weight for weight, the steel cables would now be preferred. Accidents from their breakage are extremely rare. The increased diameter of equivalent aluminum cables would be a disadvantage, while their non-corrosibility would be in their favor.

A NEW form of respirator, known as the Guilbert *apparatus respirateur*, has been tested, it is said successfully, in the gaseous coal mines of France, England, and Germany, and is on trial in this country. The apparatus was invented originally for the use of the fire departments of France, to be worn by firemen who enter buildings filled with smoke and gases in order to rescue inmates or property. It was then tried in gaseous mines, and, if it comes up to the claims made for it, will be very serviceable in the saving of life in fiery mines and rescuing victims of mine explosions and fires. The suit, as it is called, consists of a piece for the mouth and head and an air reservoir carried on the back, the air chamber being connected with the mouth and nostrils by a rubber tube, and the wearer regulating the supply of air as needed. The description given does not state whether the air is compressed, which it probably is, as has been proposed in other similar inventions. A portable incandescent electric lamp goes with the respirator, and is attached to the lappel of the coat, being fed by a small battery carried at the waist.

PORTABLE electric mining-hoists now on the market and in actual service are recommended as convenient for use in tunnels for winze work, and for prospecting purposes at a distance from the central stations. They are mounted on wheels for moving about on temporary work, though adapted to permanent service as well. This feature of ready portability is also exemplified in the electric pumps which are being introduced.

CALCULATION shows that by the use of aluminum wherever practicable in the arms and accouterments in the German armies the weight to be carried by the infantry soldier will be reduced from 68½ pounds to 57 pounds.

THE TECHNICAL INDEX.

A CATALOGUE OF LEADING ARTICLES PUBLISHED CURRENTLY IN THE TECHNICAL JOURNALS OF THE UNITED STATES AND GREAT BRITAIN.

THIS publication has been aptly described as "the greatest step that has been taken in recent years towards systematizing work" for the engineer, the architect, the electrician, the railway manager, and the business man. The list of publications regularly indexed will show that it covers a world-wide range of the best technical literature, and all the articles are so conveniently classified under general headings that within a few minutes an active man can learn of everything that has been published during the month in relation to his special lines of investigation. In short, it is to the practical man just what Poole's celebrated index to periodicals has long been to the literary worker, but with this essential difference,—namely, that in addition to indicating *just where* leading articles have been published, *we undertake to supply copies of the articles themselves.* The unparalleled convenience and economy of this double service can readily be appreciated.

In ordering articles from us, care should be taken to give the *number*, not the title alone. The price of a single article is 15 cents, excepting those indicated by an asterisk (*), 30 cents, and by a dagger (†), 45 cents—according to the price of the publication quoted. All orders *must* be accompanied by cash or stamps.

To avoid frequent remittances and to cheapen the cost of articles to those who order largely, we sell coupons at the rate of 15 cents each, or 15 for $2, 40 for $5, and 100 for $12.50. Each coupon is receivable in exchange for one 15-cent article; those marked * require two coupons, and those marked † require three coupons. This system is strongly commended. The coupons need only a trial to demonstrate their great convenience and economy of time and money.

[In the body of the index only the initials of the journals quoted are given, and these can be readily identified by the following list of periodicals. Other abbreviations are: Ill=Illustrated. w=words.]

THE AMERICAN PRESS.

A .....Arena. *m.* $5 per year. Boston.
AA.....American Architect. *w.* $6. Boston.
An A A..Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
A An.... American Analyst. *f.* $1 per year. N. Y.
A Ar.....American Artisan. *w.* $2. Chicago.
A & B....Architecture and Building. *w.* $6. N. Y.
A B M...Architect, Builder, and Manufacturer. *m.* $1.50. Kansas City, Mo.
A CJ....Am. Chemical Journal. *b-m.* $4. Baltimore.
A D.....American Druggist. *m.* $1.50. New York.
A E .....Architectural Era. *m.* $3. N. Y.
A G.....Am. Geologist. *m.* $3.50. Minneapolis.
A G L J..Am. Gas Light Journal. *w.* $3. New York.
A H.....Annals of Hygiene. *m.* $2 per year. Phila.
A J Phar.Am. Journal of Pharmacy. *m.* $3. Phila.
A J R A..Journal of Railway Appliances. *m.* $2 per year. New York.
A M .....American Machinist. *w.* $3. New York.
A M & I W.American Manufacturer and Iron World. *w.* $4 per year. Pittsburg.
Am A....American Agriculturist. *m.* $1.50. N.Y.
Am G....American Gardening. *m.* $1. N. Y.
A M M...American Mechanics. *m.* $1. Minneapolis.
Am M....American Miller. *m.* $2. Chicago.
Am S....American Shipbuilder. *w.* $2. N. Y.
A & N J..Army and Navy Journal. *w.* $6. New York.
A & N R..Army and Navy Register. *w.* $3 per year. Washington.
A R.....Architectural Record. *q.* $1. New York.
A Rev....Architectural Review. *s-q.* $5. Boston.
A S .....Age of Steel. *w.* $3. St. Louis.
At M.....Atlantic Monthly. *m.* $4 per year. Boston.
B B.....Brick Builder. *m.* $2.50. Boston.
B C.....Boston Commonwealth. *w.* $2.50.
B & D....The Builder and Decorator. *m.* $2. Minneapolis.
B G S ..Bulletin of the American Geographical Society. *q* $5. N. Y.
B I S.....Bulletin of American Iron and Steel Association. *w.* $4. Phila.
B J C....Boston Journal of Commerce. *w.* $3 per year. Boston.
B P .....Bulletin of Pharmacy. *m.* $1. Detroit.
B & W...Builder and Woodworker. *m.* $1. N. Y.
C.....Compass. *m.* $1 per year. New York.
C A.....Calif. Architect. *m.* $3. San Francisco.
Can A...Canadian Architect. *m.* $2. Toronto.
C & B....Carpentry and Building. *m.* $1. New York.
C B T....Builder and Trader. *w.* $2. Chicago.
C E .....Colliery Engineer. *m.* $2. Scranton, Pa.
C E N....Canadian Electrical News. *m.* $1 per year. Toronto.
Ch.....Chautauquan. *m.* $2. Meadville, Pa.
C M.....Century Magazine. *m.* $4 per year. N. Y.
Cos.....Cosmopolitan. *m.* $3 per year. New York.
D E.....Domestic Engineering. *m.* $1. Chicago.
D J.....Drainage Journal. *m.* $1. Indianapolis.
D Jour..Druggists' Journal. *m.* $1. Chicago.
E A.....Electrical Age. *w.* $3 per year. New York.
E E N Y..Electrical Engineer. *w.* $3 per year. N. Y.
E I.....Electrical Industries. *m.* $3. Chicago.
E M.....Engineering Mechanics. *m.* $2. Phila.
E Mag...Engineering Magazine. *m.* $3. New York.
E M J....Engineering and Mining Journal. *w.* $4 per year. New York.
E N.....Engineering News. *w.* $5 per year. N. Y.
Eng.....Engineer. *s-m.* $2 per year. New York.
E N Y....Electricity. *w.* $2.50. N. Y.
EP D....Electrical Progress and Development. $2. Boston.
E R.....Engineering Record. *w.* $5. N. Y.
E & R ...Electricity and Railroading. *m.* $1 per year. Boston.
E R N Y..Electrical Review. *w.* $3 per year. N. Y.
E W.....Electrical World. *w.* $3 per year. N. Y.
F .....Forum. *m.* $5 per year. New York.
F D.....The Foundry. *m.* $1. Detroit.
F M.....Farm Machinery. *m.* $1. St. Louis.
F W.....Fire and Water. *w.* $3 per year. N. Y.
G & F....Garden and Forest. *w* $4 per year. N.Y.
G G M...Goldthwaite's Geographical Magazine. *m.* $2 per year. N. Y.
G R.....Good Roads. *m.* $2 per year. N. Y.
I A.....Inland Architect. *m.* $5 per year. Chicago.
I Age....Inventive Age. *s-m.* $1. Washington.
Ir Age...Iron Age *w.* $4.50. N. Y.
I R W...India Rubber World. *m.* $3 per year. N. Y
I S P.....Industry. *m.* $2 per year. San Francisco.
I T R.....Iron Trade Review. *w.* $3. Cleveland.
J A .....Journal of Architecture. *m.* $2. Phila.
J A C S..Journal of the American Chemical Society. *m.* $5 per year. N. Y.
J A E S..Journal of the Association of Engineering Societies. *m.* $3 per year. Chicago.

J F I.....Journal of the Franklin Institute. *m.* $5 per year. Philadelphia.
J M S I..Journal of the Military Service Institution. *b-m.* $4 per year. Governor's Island, N. Y. H.
J N E W..Journal of the N. E. Waterworks Association. *q.* $2. New London, Conn.
J P E.....Journal of Political Economy. *q.* $3. Chicago.
J U S A..Journal of the United States Artillery. *q.* $2.50. Fort Monroe, Va.
L E.....Locomotive Engineering. *m.* $2. N. Y.
L F M...Locomotive Firemen's Magazine. *m.* $1. Terre Haute, Ind.
L M .....Leather Manufacturer. *m.* $3. N. Y.
L Mag...Lippincott's Magazine. *m.* $3. Phila.
L P .....Louisiana Planter. *w.* $3. New Orleans.
M & B...Manufacturer and Builder. *m.* $1.50. N. Y.
M & El...Mechanic and Electrician. *w.* $2 per year. St. Louis.
Met W...Metal Worker. *w.* $2 per year. N. Y.
M G .....Manufacturer's Gazette. *w.* $2.50. Boston.
Min .....Minerals. *m.* $1 per year. N. Y.
M I T.....Mining Industry and Tradesman. *w.* $3 per year. Denver.
M N.....Mechanical News. *s-m.* $1.50. New York.
M R.....Manufacturer's Record. *w.* $4. Baltimore.
M R C...Marine Review. *w.* $2. Cleveland, O.
M Rec....The Marine Record. *w.* $2. Cleveland.
M S P....Mining and Scientific Press. *w.* $3 per year. San Francisco, Cal.
M S R....Mining and Scientific Review. *w.* $2 per year. Denver.
N A R....North American Review. *m.* $5. N. Y.
N B .....National Builder. *m.* $3. Chicago.
N B D...Northwestern Builder and Decorator. *m.* $2. Minneapolis.
N C B...National Car Builder. *m.* $2. N. Y.
N M ....Northwestern Mechanic. *m.* $1. Minneapolis.
N W.....Northwestern Architect. *m.* $3. Minneapolis.
O M.....Overland Monthly. *m.* $3 per year. San Francisco.
O P D R..Oil, Paint and Drug Reporter. *w.* $6. N.Y.
P.....Paving and Municipal Engineering. *m.* $1 per year. Indianapolis.
P A.....Progressive Age. *s-m.* $3. New York.
P D.....Painting and Decorating. *m.* $1. Phila.
P E.....Practical Electricity. *f.* $2 per year. Boston.
P E C P..Proceedings of the Engineers' Club. *q.* $2 Phila.
P Era...Pharmaceutical Era. *s-m.* $2. Detroit.
P L.....Pacific Lumberman, Contractor, and Electrician. *w.* $3. San Francisco.
P M. . .Paper Mill. *w.* $3. N. Y.
P R.....Pharmaceutical Record. *s-m.* $1.50. N. Y.
P S.....Power-Steam. *m.* $1 per year. N. Y.
P S M....Popular Science Monthly. *m.* $5. N. Y.
P S N...Popular Science News. *m.* $1. Boston.
R A.....Railway Age. *w.* $4 per year. Chicago
R A E J..Railroad and Engineering Journal. *m.* $3 per year. New York.
R C J....Railroad Car Journal. *m.* $1 per year. N. Y.
R G .....Railroad Gazette. *w.* $4.20 per year. N. Y.
R M.....Roller Mill. *m.* $2. Buffalo, N. Y.
R M M..Railway Master Mechanic. *m.* $1. Chicago.
R of R..Review of Reviews. *m.* $2.50. N. Y.
R P.....Registered Pharmacist. *w.* $1. Chicago.
R R.....Railway Review. *w.* $4 per year. Chicago.
R S P....Rudder, Sail and Paddle. *m.* $2. N. Y.
R T ....Rose Technic. *m.* $1. Terre Haute, Ind.
R & T...Roofer and Tinner. *m.* $1 per year. N. Y.
R'y N....Railway News. *m.* $2. N. Y.
S.....Stone. *m.* $2 per year. Indianapolis, Ind.
S A.....Southern Architect. *m.* $1. Atlanta.
San.....Sanitarian. *m.* $4 per year. Brooklyn.
Sc.....Science. *w.* $3.50 per year. New York.
Sc A....Scientific American. *w.* $3. N. Y.
Sc A S...Scientific American Supplement. *w.* $5. N. Y.
Sc M....Scribner's Magazine. *m.* $3. N. Y.
S E .....Stationary Engineer. *w.* $2. Chicago.
Sea.....Seaboard. *w.* $2 per year. N. Y.
S Ec.....Social Economist. *m.* $2. New York.
S Era....Sanitary Era. *m.* $1 per year. N. Y.
S J E....Sibley Journal of Engineering. *m.* $2. Ithaca, N. Y.
S M.....Scientific Machinist. *m.* $1.50. Cleveland, O.
So L.....Southern Lumberman. *s-m.* $2. Nashville, Tenn.
S M Q...School of Mines Quarterly. $2. N. Y.
S P .....Sanitary Plumber. *s-m.* $1. N. Y.
S R G....Street Railway Gazette. *w.* $3. Chicago.
S R J....Street Railway Journal. *m.* $4. New York.
S R N...Street Railway News. *w.* $3. N. Y.
S R R....Street Railway Review. *m.* $2. Chicago.
S V.....Safety Valve. *m.* $1 per year. N. Y.
T .....Tradesman. *s-m.* $2. Chattanooga, Tenn.
T A I E E.Transactions American Institute of Electrical Engineers. *m.* $5 per year. N. Y.
T C E....Transactions American Society of Civil Engineers. *m.* $10. N. Y.
T Q .....Technology Quarterly. $3. Boston.
W E.....Western Electrician. *w.* $3. Chicago.
W F E E..World's Fair Electrical Engineering. *m.* $3. Chicago.

THE FOREIGN PRESS.

A L ....The Architect. *w.* 26*s.* London.
A M S...Australian Mining Standard. *w.* 30*s.* per year, postpaid. Sydney, Australia.
B A.....The British Architect. *w.* 23*s.* 8*d.* London.
C G.....Colliery Guardian. *w.* 27*s.* 6*d.* per year, post-paid. London.
C R.....Contemporary Review. *m.* $4.50 per year, New York. London.
C T J....Chemical Trade Journal. *w.* 12*s.* 6*d.* per year, post-paid. Manchester, Eng.
D .....Discovery. *w.* 8*s.* 8*d.*, post-paid. London.
E.....Engineering. *w.* 36*s.*, post-paid. London.
E E L....Electrical Engineer. *w.* 17*s.* 4*d.* per year, post-paid. London.
E G.....Engineers' Gazette. *m.* 4*s.*, post-paid. London.
E L.....Electricity. *w.* 6*s.* 6*d.*, post-paid. London.
El .....Electrician. *w.* 24*s.* post-paid. London.
Eng L...Engineer. *w.* 36*s.*, post-paid. London.
E P.....Electrical Plant. *m.* 6*s.* per year, post-paid. London.
E R L....Electrical Review. *w.* 21*s.* 8*d.* per year, post-paid. London.
F R.....Fortnightly Review. *m.* $4.50 per year. New York. London.
G E M...Gas Engineers' Magazine. *m.* 6*s.* 6*d.* per year, post-paid. Birmingham, Eng.
G W.....Gas World. *w.* 13*s.*, post-paid. London.
I.....Iron. *w.* 30*s.* per year, post-paid. London.
I & S.....Iron and Steel Trades' Journal. *w.* 25*s.*, post-paid. London.
I C B....Illustrated Carpenter and Builder. *w.* 8*s.* 8*d.* per year, post-paid. London.
I C T....Iron and Coal Trades' Review. *w.* 30*s.* 4*d.*, post-paid. London.
I E.....Indian Engineering. *w.* Rs. 18 per year, postage extra. Calcutta.
I Eng....Indian Engineer. *w.* Rs. 15 per year, postage extra. Calcutta.
I L. .....Industries. *w.* 32*s.*, post-paid. London.
Inv.....Invention. *w.* 28*s.*, post-paid. London.
J G L....Journal of Gas Lighting. London.
J S A....Journal of the Society of Arts. *w.* London.
K.....Knowledge. *m.* 6*s.*, post-paid. London.
M.....Machinery. *m.* 9*s.*, post-paid. London.
M E.....Marine Engineer. *m.* 7*s.* 6*d.* per year, post-paid. London.
M E & E J..Manufacturers' Engineering and Export Journal. *m.* London.
Min W..The Mining World. *w.* 21*s.* post ex. London.
M W.....Mechanical World. *w.* 8*s.* 8*d.* per year, post-paid. London.
N..... Nature. *w.* $7, post-paid. London.
N C.....Nineteenth Century. *m.* $4.50 per year. New York. London.
P Eng...Practical Engineer. *w.* 10*s.* per year, post-paid. London.
Pl D .....Plumber and Decorator. *m.* 6*s.* 6*d.*, post-paid. London.
Rev R...Review of Reviews. *m.* $2.50. New York. London.
R N.....Railway News. London.
R R L....The Railway Review. *w.* London.
R W.....Railway World. *m.* $3, post-paid. London.
S L.....Steamship. *m.* Leith, Scotland.
S R.....Sanitary Record. *m.* London.
W R.....Westminster Review. *m.* $4.50 per year. N. Y. London.

ARCHITECTURE.

10537. New Office Buildings in Chicago. Ill. (E N-Feb. 16.) 2400 w.

10542. A Notable Concrete Building. Ill. (E N-Feb. 16) 700 w.

10558. St. Louis Requirements for Slow Combustion Buildings (E R-Feb. 18.) 1400 w.

*10683. Slate and Slate Quarrying. Ill. George H. Harris (S-Feb.) 2700 w.

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*10687. Stone and Its Uses H. F. Perry (S-Feb.) 2000 w.

*10711. Tests of Building Stones. Ill. (Can A-Feb.) 1800 w.

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10759. The Caisson Foundations of the Manhattan Life Insurance Building.—Letters from Charles Sooysmith, and Kimball & Thompson (A A-Feb. 18.) 1250 w.

10786. A Vicar's Views of Church Restoration. T. Perkins (B A-Feb. 17.) 950 w.

*10810. The Value of Criticism. C. J. Tait (A L-Feb. 17.) 6000 w.

*10811. The Theory of Storiation in Art. Hugh Stannus (A L-Feb. 17.) 8000 w.

10814. Town Gates in Southern Germany. Ill. (A A-Feb. 25.) 2200 w.

10815. The March of Ancona. M. W. (A A-Feb. 25.) 1800 w.

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10918. Glass Houses. Ill. (Am G-Feb.) 5000 w.

*10928. Whither Is Our Architecture Tending? C. W. Hopkins (B & D-Feb.) 2600 w.

10932. Decoration of Ceilings (C & B-March.) 1700 w.

10933. Safe Scaffolding. Ill. (C & B-March.) 1700 w.

10934. Designs in Slate Roofing. Ill. (C & B-March.) 1100 w.

10956. The Architect and His Materials. George P. Merrill (A A-March 4.) 2200 w.

10958. Sketches of Italian Architects.—Palladio. Arthur Gilman (A A-March 4.) 3000 w.

*10999. The Windows in York Cathedral (A L-Feb. 24.) 1600 w.

*11000. Our Duty in Respect of Ancient Buildings. W. W. Robertson (A L-Feb. 24.) 6500 w.

Serials.

2285. Construction. Ill. M. Viollet-le-Duc (A A-Began Feb. 20, 1892—19 parts to date—15 cts. each).

7121. Office-Help for Architects. George Hill (A A-Began Oct. 8—7 parts to date—15 cts. each).

10290. Notes on the Use of Iron and Steel in Building Construction. J. W. Ashcroft (I-Began Jan. 27—Ended Feb. 10—2 parts—30 cts. each).

10673. Architectural Terra Cotta (B B-Began Jan.—1 part to date—30 cts).

10682. The Chateaux of France. Ill. Louis H. Gibson (S-Began Feb.—1 part to date—30 cts).

10756. The Languedocian School of Architecture. Ill. Anthyme Saint Paul (A A-Began Feb. 18—3 parts to date—15 cts. each).

10960. The Origin of Building. H. J. Williams (A & B-Began March 4—1 part to date—15 cts).

CIVIL ENGINEERING.

†10525. "Overhead Reservoir." Ill. (I E-Jan. 14.) 1600 w.

10533. Anti-Freezing Soda-Mortar (E N-Feb. 16.) 500 w.

10534. Some Recent Examples of Monier Arch Construction. Ill. (E N-Feb. 16.) 700 w.

10538. A 35-Ton Traveling Crane for Harbor Work. Ill. (E N-Feb. 16.) 800 w.

10539. Letting Highway Bridge Contracts. Editorial and Letters (E N-Feb. 16.) 4500 w.

10608. The South Halsted Street Lift Bridge, Chicago. Ill. (R R-Feb. 18.) 2700 w.

*10636. Manchester Canal Financial Difficulties. Editorial (E-Feb. 10.) 1300 w.

10651. The Panama and Nicaragua Canals. F. R. Brainard (Sc A-Feb.25.) 1800 w.

*10674. Note on the Compressive Resistance of Brick (B B-Jan.) 500 w.

10691. The Actual Resistance of Bearing Piles (E N-Feb. 23.) 3000 w.

10692. Concrete Conduit in Tunnel of the Santa Aña Valley Irrigation Co., Orange County, Cal. Ill. H. C. Kellogg (E N-Feb. 23.) 600 w.

10707. A Controverted Question in Road Construction. James Owen (R G-Feb. 24.) 2500 w.

10710. The Nicaragua Canal. A. G. Menocal (R G-Feb. 24.) 3000 w.

†10717. Panama: The Story of a Colossal Bubble. Ernest Lambert (F-March.) 5200 w.

10750. The Corinth Canal. Editorial (E R-Feb. 25.) 900 w.

10751. A Method of Tunnel Alignment. H. F. Dunham (E R-Feb. 25.) 1800 w.

†10775. Vizagapatam Harbor. G. E. Moore (I E-Jan. 21.) 1300 w.

*10781. River Severn Improvements (Eng L-Feb. 17.) 2000 w.

†10870. Vizagapatam Harbor. G. T. Walch (I E-Jan. 28.) 2000 w.

*10923. Paving Brick: Their Manufacture and Use, with Discussion. W. S. Williams (P-March.) 3000 w.

10938. The Restoration of the Cable Ends of the Covington and Cincinnati Suspension Bridge. Abstract of paper by G. Bouscaren (E R-March 4.) 800 w.

10959. The Tower Bridge, London (A A–March 4.) 1800 w.

11025. Reconstructing a Pittsburg Bridge (R G–March 3.) 700 w.

*11033. Road Improvement in New York. Ill. Roswell P. Flower (G R–Feb.) 1500 w.

*11034. Good Roads and School Attendance. Francis J. Cheney (G R–Feb.) 1000 w.

*11035. Wheel-Tires and Axles. How They Can Be Made to Keep the Road Smooth. Ill. William A. Sweet (G R–Feb.) 500 w.

*11053. The St. Clair Tunnel. Ill. (R W–Feb.) 2200 w.

11090. The Construction and Maintenance of Howe Truss Bridges. Charles H. Nichols (E N–March 9.) 1800 w.

11091. An Interesting Example of False Work Construction. Ill. J. F. Jackson (E N–March 9.) 1800 w.

Serials.

8671. MacAdam and Telford Roads. Ill Isaac B. Potter (G R–Began Nov.—2 parts to date—30 cts. each).

9523. Maintenance of Roads in France. Arthur Lagton (P–Began Jan.—3 parts to date—30 cts. each).

10455. The Bridges of the Manchester Canal. Ill. (E–Began Feb. 3—2 parts to date—30 cts. each).

10665. The Panama Canal. Ill. (I L–Began Feb. 10—Ended Feb. 17—2 parts—30 cts. each).

10780. Dredging. W. H. Wheeler (Eng L–Began Feb. 17—1 part to date—30 cts).

11036. Staten Island Highways. Ill. (G R–Began Feb.—1 part to date—30 cts).

ELECTRICAL MISCELLANY.

10513. Edison's New Art of Generating Electricity. Ill. (Sc A–Feb. 18.) 1000 w.

*10528. Transformers and Sub-Stations. W. H. Trentham (E E L–Feb. 3.) 800 w.

†10552. Note on the Descriptive Strength of Dielectrics. Ill. Charles Proteus Steinmetz (T A I E E–Feb.) 3600 w.

*10616. Theory and Practice in Electrical Science. Alexander Siemens (El–Feb. 10.) 900 w.

*10637. The Practical Measurement of Alternating Electric Currents. J. A. Fleming (E–Feb. 10.) 1800 w.

10660. A Simple System for Operating Electric Clocks. Ill. R. G. Brown (E E N Y–Feb. 22.) 500 w.

10661. On Distribution of Potential. Ill. George P. Huhn (E E N Y–Feb. 22.) 400 w.

10667. The Future Ohm, Ampere, and Volt. H. S. Carhart (Sc–Feb. 17.) 1200 w.

10671. Shunt Motors. W. D. Weaver (E W–Feb. 25.) 1600 w.

10700. MacLeod's Improvements in Accumulators. Ill. (W E–Feb. 25.) 600 w.

10701. Experiments with Electric Waves (W E–Feb. 25.) 900 w.

10761. Nikola Tesla (B J C–Feb. 25.) 1000 w.

*10769. Giraud's Thermo-Electric Stove. Ill. (E L–Feb. 17.) 500 w.

*10794. The Magnetic Properties of Substances at Various Temperatures. Ill. P. Curie (El–Feb. 17.) 200 w.

*10807. The Practical Measurement of Alternating Electric Currents. Ill. J. A. Fleming (E–Feb. 17.) 1500 w.

*10808. The Development and Transmission of Power from Central Stations. Prof. Unwin (E–Feb. 17.) 4800 w.

10816. Electric Power from Niagara Falls. Prof. George Forbes Talks Interestingly. J. A. M. (E R N Y–Feb. 25.) 2200 w.

10820. One Year of Electricity.—Gleanings by the "Electrical Review" During the Past Year. Ill. (E R N Y–Feb. 25.) 10,000 w.

10821. The Place of Electricity in the Modern Office Building (E R N Y–Feb. 25.) 1200 w.

*10830. Novel Effects of the Electric Discharge. Lord Armstrong (E R L–Feb. 17.) 3200 w.

10836. The Works of the Eddy Electric Manufacturing Company at Windsor, Conn. Ill. (E R N Y–March 4.) 1800 w.

10837. Is the Steam Locomotive an Electric Generator? (E R N Y–March 4.) 600 w.

10843. Conductors and Insulators. Reginald R. Fessenden (E W–March 4.) 2000 w.

10845. The Application of the Electric Motor in Commercial Industries. Ill. (E W–March 4.) 800 w.

10847. Growth of American Electrical Industries (E W–March 4.) 400 w.

10862. A Wire Gage Chart for Determining the Ampere Turns on Shunt Magnets. Ill. William R. C. Corson (E E N Y–March 1.) 750 w.

10863. The Scott-Sisling System for Accumulator Installations. Ill. W. B. Sisling (E E N Y–March 1.) 300 w.

10885. Storage Batteries in Practice. J. R. Pumpelly (S E–Feb. 25.) 2000 w.

10943. Storage Batteries, Secondary Cells, or Accumulators. W. B. Shaw (C E N–March.) 1800 w.

10954. The Effect of Short Circuits on Dynamos (P S–March.) 1500 w.

10961. Poles. Ill. G. A. Wall (S R N–March 4.) 1900 w.

*10981. The Development and Transmission of Power from Central Stations. W. C. Unwin (El–Feb. 24.) 4500 w.

*10992. Lord Kelvin's New Engine-Room Watt-Meter (E E L–Feb. 24.) 500 w.

*10994. How to Design a Small Motor. Ill. E. Meylan (E E L–Feb. 24.) 3000 w.

*10996. Ships' Electrical Fittings for Lighting, Signalling, Telegraphing, and for Motive Power. Ill. L. Newitt (E E L–Feb. 24.) 3600 w.

*10998. Moissau's Electric Furnace (E E L–Feb. 24.) 1000 w.

*11016. The Personnel of the Business Side of Electrical St. Louis. Ill. (E I-March.) 2800 w.

*11018. Power Transmission by Electric Motors in the Fraser and Chalmers' Plant. Ill. (E I-March.) 1000 w.

11045. Wrought Iron vs. Cast Iron for Field Magnet Frames. A. D. Adams (E A-March 4.) 600 w.

*11052. Heating in Voltaic Cells. Ill. T. H. Muras (E R L-Feb. 24.) 450 w.

11063. Remarks Concerning Power Transmission from the Economic Standpoint. L. B. Stillwell (E E N Y-March 8.) 1800 w.

11064. Long Distance Transmission of Power. Charles S. Bradley (E E N Y-March 8.) 1200 w.

11066. Power Transmission for Central Stations. Louis Bell (E E N Y-March 8.) 2700 w.

11077. An Induction Coil for Alternating Currents. Ill. R. W. Wood (Sc A-March 11.) 1800 w.

11080. Electrical Transmission (M N-March 1.) 450 w.

Serials.

2784. Insulated Electric Conductors. Ill. James Bowstead Williams (E E N Y-Began March 16, 1892—19 parts to date—15 cts. each).

5543. Light and Power Stations. Robb Mackie (E R N Y-Began July 23—14 parts to date—15 cts. each).

9374. Laminated or Divided Iron and Other Metallic Masses in Electromagnetic Apparatus. Thomas D. Lockwood (E E N Y-Began Jan. 4—Ended Feb. 22—8 parts—15 cts. each).

9771. What Is Electricity? S. F. Walker (E E L-Began Jan. 6—3 parts to date—30 cts. each).

10147. William Wallace and his Contributions to the Electrical Industries. Ill. W. J. Hammer (E E N Y-Began Feb. 1—Ended Feb. 22—4 parts—15 cts. each).

10170. Electrical Oscillations of High Frequency. Ill. Erwin S. Ferry (E W-Began Feb. 4—3 parts to date—15 cts. each).

10325. The Electrical side of St. Louis. Ill. (E W-Began Feb. 11—4 parts to date—15 cts. each)

10600. Electrical Measurements. Ill. George D. Shepardson (S R R-Began Feb.—1 part to date—30 cts).

10615. On the Determination of the Insulation Resistance and of Faults in Electrical Plants During the Working. Ill. O. Froelich (El-Began Feb. 10—Ended Feb. 24—3 parts—30 cts. each).

10659. Influence of Frequency in the Working of Alternate Current Transformers. Ill. Charles Steinmetz (E E N Y-Began Feb. 22—2 parts to date—15 cts. each).

10995. On Testing and Working Alternators. W. M. Morley (E E L-Began Feb. 24—1 part to date—30 cts).

11046. Some Experiences with the Alternating System. R. H. Sterling (E A-Began March 4—1 part to date—15 cts).

ELECTRIC LIGHTING.

†10551. Discussion of Caryl D. Haskin's paper on "Electrical Recording Meters" (T A I E E-Feb.) 5400 w.

†10553. The Most Economical Age of Incandescent Lamps. Carl Hering (T A I E E-Feb.) 3000 w.

10662. Incandescent Lamp Litigation.—The Goebel Claims Rejected (E E N Y-Feb. 22.) 7500 w.

10666. Edison Lamp Patent Stands.—Judge Colt's Decision in the Beacon Company's Case (E N Y-Feb. 22.) 2500 w.

10672. Handy Wiring Tables (S E-Feb. 18.) 300 w.

*10739. The Johnstone System of Electrical Underground Conduits. Ill. (I-Feb. 17.) 1500 w.

*10793. Concentric Wiring. Sam Mavor (El-Feb. 17.) 1700 w.

10817. The Largest Arc Light Plant in the World.—The Municipal Electric Lighting and Power Company of St. Louis. Ill. (E R N Y-Feb. 25.) 2200 w.

10818. Edison Again.—Judge Colt Grants Another Injunction (E R N Y-Feb 25.) 8000 w.

10823. The Durability of Underground Wires. Herbert Laws Webb (E R N Y-Feb. 25.) 1000 w.

*10829. Installation for Electric Light and Power at Benatek, Bohemia (E R L-Feb. 17.) 1500 w.

10838. Rules for Electric Light Work Adopted at St. Louis (E R N Y-March 4.) 6000 w.

10858. An Historic Edison Plant. S. S. "Columbia." Ill. (E E N Y-March 1.) 700 w.

10859. Electric Lighting in Churches:—St. Francis Xavier's, New York. Ill. John McGhie (E E N Y-March 1.) 900 w.

10872. Glowing of Disconnected Incandescent Lamps. Ill. N. S. Amstutz (E N Y-March 1.) 600 w.

10874. A Model Lighting Station.—The Brooklyn Edison Illuminating Company's New Plant on Gwinnett Street. Ill. (E N Y-March 1.) 2600 w.

10884. Steam and Lighting Plant of the Masonic Temple Building, Chicago. Ill. (S E-Feb. 25.) 1200 w.

*10980. Latitude and the Load-Factor. Ill. E. Tremlett Carter (El-Feb. 24.) 1100 w.

*10986. Indirect Lighting (G W-Feb. 25.) 1600 w.

*10990. Electricity at the Theatres. Ill. (E E L-Feb. 24.) 1100 w.

*10993. Pioneer Electric Lighting in South America (E E L-Feb. 24.) 900 w.

*10997. Electric Light at the Brussels Post Office (E E L-Feb. 24.) 1100 w.

*11015. The Stations of Electric Light Companies of St. Louis. Ill. (E I-March.) 2000 w.

11019. Dangers from Gas in Electrically Lighted Cities. Ill. M. P. Jousselin (W E-March 4.) 5000 w.

11044. Relation of Insurance to Electric Lighting and Power. William Brophy (E A-March 4.) 1600 w.

11065. The Incandescent Lamp from a Commercial Standpoint. Calvert Townley (E E N Y-March 8.) 1800 w.

11067. Underground Conduits and Conductors and the Experiences of Electric Lighting Companies of New York City. William H. Brown (E E N Y-March 8.) 1800 w.

11068. Thermal Storage for Central Stations. George Forbes (E E N Y-March 8.) 1500 w.

11069. President Ayer's Address (E E N Y-March 8.) 2000 w.

11070. The Tesla Lecture in St. Louis (E E N Y-March 8.) 2000 w.

11096. Panel Distribution Board. Ill. (E R N Y-March 11.) 600 w.

Serials.

6709. Electric Light and Power. Ill. Arthur F. Guy (E E L-Began Sept. 9—16 parts to date—30 cts. each).

9531. Suggestions for Metering Devices. Ill. S. D. Mott (E W-Began Jan. 14—4 parts to date—15 cts. each).

9906. Electric Light and Gas. Ed. C. de Segundo (E R L-Began Jan. 13—3 parts to date—30 cts. each).

10403. Evolution of Electric Lighting. W. H. Wakeman (M G-Began Feb. 11—Ended Feb. 18—2 parts—15 cts. each).

10844. The Design of a Central Station for Incandescent Electric Lights. E. P. Roberts (E W-Began March 4—1 part to date—15 cts).

GAS ENGINEERING.

*10545. Experimenting with a View to the Development of Gasholder Construction. E. L. P. (J G L-Feb. 7.) 1000 w.

10578. The Fitch Process. Ill. (P A-Feb. 15.) 800 w.

10650. New Method of Gas Supply for New York City (Sc A-Feb. 25.) 1000 w.

10748. Experiments on Removing Sulphur from Purified Gas,—with Discussion. Mr. Goodno (A G L J-Feb. 27.) 2800 w.

10749. Reports with Discussion. Robert N. Bush (A G L J-Feb. 27.) 3000 w.

*10800. Inaugural Address of C. C. Carpenter (G W-Feb. 18.) 6500 w.

*10824. Cooking-Gas at Copenhagen (J G L-Feb. 14.) 1600 w.

*10825. The Use of Air for the Purification of Gas. Norton H. Humphreys (J G L-Feb. 14.) 2100 w.

10865. The Gas Engine (Sc A S-March 4.) 700 w.

10929. Effects of the Trolley System on Gas and Water Pipes, with Discussion. H. A. Allyn (A G L J-March 6.) 5400 w.

10930. Recording Pressures on Mains and Services, with Discussion. S. J. Fowler (A G L J-March 6.) 5600 w.

10931. The New Plant of the Altoona (Pa.) Gas Company. T. W. Cole (A G L J-March 6.) 1500 w.

*10987. A Look into the Distribution Department. Paulos Thieman (G W-Feb. 25.) 5400 w.

HYDRAULICS.

†10523. Mr. Doig's Report on the Shone System at Rangoon. Xen (I E-Jan. 14.) 550 w.

†10524. Sanitary Engineering in India. Pump (I E-Jan. 14.) 500 w.

10541. Reduction of Water Consumption by Meters (E N-Feb. 16.) 1700 w.

*10544. Presidential Address of W. A. Valon (J G L-Feb. 7.) 7500 w.

10548. New England Water Power (P M-Feb. 16.) 800 w.

†10583. Artesian Waters in the Arid Region. Ill. Robert T. Hill (P S M-March.) 4300 w.

*10633. Discussion of William Matthews' paper—"Description of the Pumping Engines and Water Softening Machinery at the Southampton Water Works" (E-Feb. 10.) 5000 w.

*10654. The Jet Water Wheel. C. R. Tompkins (Am M-Jan. 1.) 1000 w.

10729. Niagara Must Go to Work (P M-Feb. 23.) 900 w.

10752. The Formation of Sand Filters. Ill. (E R-Feb. 25.) 2000 w.

*10785. Joseph Moore's Patent Hydraulic Pumping Arrangement (C G-Feb. 17.) 2000 w.

*10806. Water Power of the Periyar River (E-Feb. 17.) 900 w.

10877. Niagara Falls in Harness (P A-March 1.) 2000 w.

10897. The Discharge of the Niagara River. Ill. (E N-March 2.) 3400 w.

*10906. The Dam and Power at Holyoke, Mass. Ill. (R M-Feb.) 1200 w.

10969. The Irrigation Question from a Botanical Standpoint. Frederick Vernon Coville (E M J-March 4.) 1000 w.

11072. Hydraulic Reaction Motors.—Abstract of paper by De Volson Wood (A M-March 9.) 1300 w.

11074. The Hydro-Electric Distribution of Power and Electric Energy. Ill. E. Hospitalier (Sc A S-March 11.) 1700 w.

11088. A Water Filtration Plant at Leeuwarden, Holland. Ill. (E N-March 9.) 900 w.

Serials.

9998. American Turbine Water-Wheels. Ill. Samuel Webber (Ir Age-Began Jan. 26—Ended March 2—5 parts—15 cts. each).

10988. Water-Power Utilization. Ill. W. H. Booth (E L-Began Feb. 24—1 part to date—30 cts).

We supply copies of these articles. See introductory.

INDUSTRIAL CHEMISTRY.

*10627. The Distillation of Coal. Pierre Mahler (C G-Feb. 10.) 350 w.

*10744. The Manufacture of Nitric Acid (I L-Feb. 17.) 1800 w.

*10827 Note on the Purification of Mercury. Ill. M. W. Jaeger (E R L-Feb. 17.) 800 w.

†11057. The Effect of Decomposing Matter on Natural Phosphates. N. T. Lupton (J A C S-Dec.) 1600 w.

11062. Carborundum :—Its Manufacture and Use. Ill. E. G. Acheson (E E N Y-March 8.) 2000 w.

Serials.

11049. The Applications of Ozone (E R L-Began Feb. 24—1 part to date—30 cts).

INDUSTRIAL SOCIOLOGY.

*10500. The Industrial Problem in Australia. Ill. Edmund Mitchell (E Mag-April.) 3000 w.

*10503. Fallacies and Facts as to Immigration. John B. Weber (E Mag-April.) 3000 w.

*10504. The Dearness of "Cheap" Labor. David F. Schloss (E Mag-April.) 3000 w.

10579. Wages. Editorial (A M M-Feb.) 2000 w.

†10580. The Taxation of Ground Rents. J. Powell Williams (N C-Feb.) 7300 w.

*10635. The Liability of Employers for Accidents to Workmen. Editorial (E-Feb. 10.) 1500 w.

*10688. Strikes, Their Effects and Remedies. J. H. Peter (S-Feb.) 1300 w.

*10689. National Organization of Quarrymen. Sylvester Marshall (S-Feb.) 7000 w.

†10718. A New Era for the United States. George W. Medley (F-March.) 3000 w.

†10721. The Condition of Wage-Earning Women. Clare de Graffenreid (F-March.) 6800 w.

10723. Direct Trade and Agriculture. I. W. Avery (M R-Feb. 24.) 1300 w.

*10875. Where Do Wages Come From? (J G L-Feb. 21.) 2000 w.

*10983. The Forty-Eight Hour Week. Editorial (Eng L-Feb. 24.) 2000 w.

11089. The Development of Technical Societies. John Birkinbine (E N-March 9.)1400 w.

Serials.

11056. The Social Quagmire and the Way Out of It. Alfred R. Wallace (A-Began March —1 part to date—45 cts).

LANDSCAPE ENGINEERING.

10917. Villa-Garden Landscapes. James MacPherson (Am G-Feb.) 1000 w.

10945. Grasses for Lawns. C. L. Allen (Am A-March.) 600 w.

MARINE ENGINEERING.

10517. To Encourage American Shipbuilding (B I S-Feb. 15.) 800 w.

10554. Direct Foreign Trade for the South. H. B. Crosby (M R-Feb. 17.) 1200 w.

10586. Steamship Manitou, Lake Michigan and Lake Superior Transportation Co. Ill. (M R C-Feb. 16.) 2200 w.

*10634. Thornycroft's Screw Turbine Propeller. Ill. (E-Feb. 10) 1000 w.

*10686. Decadence of American Shipping. Alexander H. Smith (S-Feb.) 1400 w.

*10731. The Abysmal Depths of the Sea. Ill. J. Carter Beard (Cos-March.) 2200 w.

*10735. The British Navy. Ill. S. Eardley-Wilmot (Cos-March.) 4800 w.

10771. Seaboard Accommodates Secretary Foster. Alexander R. Smith (Sea-Feb. 23.) 1500 w.

10772. The American Line. Ill. (Sea-Feb. 23.) 1800 w.

10864. The Monterey. Ill. (Sc A S-March 4.) 900 w.

10866. American Ocean Commerce. Editorial (Sc A-March 4.) 1000 w.

10869. Raising the Flag on the Steamship New York. Ill. (Sc A-March 4.) 1200 w.

10894. Our First Battle-Ship—The Indiana. Ill. (Sea-March 2.) 550 w.

10895. Successful Preliminary Trial of the Steamship Howard Cassard (Sea-March 2.) 1100 w.

10926. F. W. Wheeler's No. 100.—A Great Shipping Record. Ill. (M R C-March 2.) 1800 w.

*10970. Chicnecto Ship Railway.—History and Manner of the Transportation of Ships (R A E J-March.) 1800 w.

*10984. The Protection of English Commerce. Editorial (Eng L-Feb. 24.) 1200 w.

11020. The Bernstein Sculling Propeller. Ill. (Am S-March 2.) 800 w.

*11042. The Coaling of Ocean Steamers (C G-Feb. 24.) 1500 w.

11073. The German Dispatch Boat "Hohenzollern." Ill. (Sc A S-March 11.) 850 w.

11076. The Coming Naval Review. Editorial (Sc A-March 11.) 650 w.

11078. United States Steamship "Iowa." Ill. (Sc A-March 11.) 700 w.

11079. An Automatic Wave Subduer. Ill. (M N-March 1.) 650 w.

Serials.

10888. Marine Propulsion. Ill. I. McKim Chase (A M-Began March 2—1 part to date—15 cts).

10893. American Marine. William W. Bates (Sea-Began March 2—2 parts to date—15 cts. each).

MECHANICAL ENGINEERING.

*10567. The Durability of Wire Ropes. Ill. M. Jacob (C E-Feb.) 2700 w.

*10574. A Test of Viscosimeters. G. F. Wagner and K. B. Miller (S J E-Feb.) 1400 w.

10653. Conical vs. Cylindric Cam Boilers. S. W. Robinson (A M-Feb. 23.) 700 w.

10668. Proper Use of Terms. Carl Hering (E W-Feb. 25.) 1000 w.

10676. The Sellers 40-Ton Dock Crane. Ill. (Ir Age-Feb. 23.) 1000 w.

*10747. A Novel Cycle Boat —Zimer's Patent. Ill. (Inv-Feb. 18.) 900 w.

10770. The Serrell Improved Derrick. Ill. (A M & I W-Feb. 24.) 1200 w.

*10803. The Dredge-Steward Omnitelemeter. Ill (E-Feb. 17.) 1200 w.

10834. Superintendence. B. F. Spalding (A S-Feb. 25.) 2000 w.

10887. Rotary Protractor for Circular and Band Saws. Ill. John M. Richardson (A M-March 2.) 2100 w.

10889. Cylindrical vs. Conical Cam Rollers. Oberlin Smith (A M-March 2.) 500 w.

10898. The Price Current Meter. Ill. (E N-March 2.) 900 w.

10902. Concerning Rivet Values. Ill. Friedrich Edler von Emperger (E N-March 2.) 1100 w.

11031. Danger in the Grind-Stone (M & B-Feb.) 600 w.

11075. The Casting of a Large Steam Cylinder. Ill. (Sc A-March 11.) 700 w.

11084. A Weldless Chain. Ill. (I T R-March 9.) 2100 w.

Serials.

7865. Notes on Rope Driving. Ill. M. E. (A M-Began Nov. 10—3 parts to date—15 cts. each).

8318. Principles, Possibilities, Curiosities, and Limitations of the Crank Motion. Leicester Allen (Eng-Began Nov. 26—Ended Feb. 18—6 parts—15 cts. each).

11039. Helico Centrifugal Ventilator. Ill. M. Rateau (C G-Began Feb. 24—1 part to date —30 cts).

11082. Belts—The Influence of Speed—Dimensions of Pulleys. Charles A. Hague (E A-Began March 11—1 part to date—15 cts).

METALLURGY.

*10569. Going into Blast with a Coke Furnace. J. S. Kennedy (C E-Feb.) 4000 w.

*10625. The Durham Coke Trade (C G-Feb. 10.) 1000 w.

*10629. Soldering Aluminum (I-Feb. 10.) 600 w.

*10631. "Metallurgical Errors." J. E. Stead (I-Feb. 10.) 1900 w.

10640. The Bates Steel Process (A S-Feb. 18.) 700 w.

*10644. New South Wales Coke. Edward T. Pittman (A M S-Jan. 7.) 2500 w.

10679. Lamination in Metal (Ir Age-Feb. 23.) 900 w.

10712. The Production of the Precious Metals in 1892—Director of the Mint's Report (E M J-Feb. 25.) 1000 w.

10713. Use of Producer Gas for Drying and Roasting Ore at the Lixiviation Mill of the Holden Smelting and Milling Company, Aspen, Colo. Willard S. Morse (E M J-Feb. 25.) 550 w.

*10741. Some Remarks on Ore Imports from Spain in 1892. Walter J. May (I-Feb. 17.) 1000 w.

*10778. The Bates' Process—Letters from Vulcan and H. Augustus Guy (I & S-Feb. 18.) 900 w.

*10779. The Swedish Iron Industry (I & S-Feb. 18.) 1600 w.

*10788. Ferro-Metallic Compounds (C G-Feb. 17.) 1800 w.

10832. The Effect of Cold on Iron and Steel (R R-Feb. 25.) 500 w.

10880. The Greene-Wahl Process of Manufacturing Manganese and Alloys of Manganese Free from Carbon. F. Lynwood Garrison (Ir Age-March 2.) 2300 w.

10881. Titaniferous Ores in the Blast Furnace. Auguste J. Rossi (Ir Age-March 2.) 2100 w.

10883. A Visit to the Property and Plants of the Canada Iron Furnace Company (Ir Age-March 2.) 6000 w.

10890. Wanted a Wire Gage. Oberlin Smith (A M-March 2.) 1100 w.

10966. The Future of Platinum. Editorial (E M J-March 4.) 900 w.

*10975. Description of a 28-Inch Steel Mill, with Shears and Subsidiary Plant for the New British Iron Company, Limited, Birmingham. Jeremiah Head (I-Feb. 24.) 2200 w.

*10976. Chinese Metallurgical Undertakings. C. T. Gardner (I-Feb. 24.) 1400 w.

*10977. Ingot Molds. James Riley (I-Feb. 24.) 1200 w.

*10985. Coal and Coke Conveyors for Retort Houses and Coal Stoves. Ill. (Eng L-Feb. 24.) 1500 words.

10989. The Lead Ore Problem. Editorial (M I T-March 2.) 1100 w.

*11038. Low Grade Surface Hematite Ores and Their Treatment. Walter J. May (C G-Feb. 24.) 1500 w.

*11050. Palladium Plating (E R L-Feb. 24.) 900 w.

†11058. The Constitution of Nickeliferous Pyrrhotite. H. S. Emmens (J A C S-Dec.) 1500 w.

11083. Pig Iron Possibilities of Marquette. Richard A. Parker (I T R-March 9.) 2500 w.

Serials.

9459. The Manufacture of Coke. John Fulton (C E-Began Jan.—2 parts to date—30 cts. each).

10266. Castings. S. Bolland (F D-Began Dec.—2 parts to date—15 cts. each).

10275. The Analysis of Iron and Steel. J. Parry and J. J. Morgan (I L-Began Jan. 27—3 parts to date—30 cts. each).

10410. Development of the Coke Industry by Utilization of By-Products. B. Leistikow (A M & I W-Began Feb. 10—Ended Feb. 17—2 parts—15 cts. each).

10630. Engineer's Tests for Iron, Considered from an Ironmaster's Point of View. Thomas Morris (I-Began Feb. 10—Ended Feb. 17—2 parts—30 cts. each).

10892. Some Points in Silver-Milling by Amalgamation. C. H. Aaron (M S P-Began Feb. 25—2 parts to date—15 cts. each).

10971. The Resistance of Metal to Shear. Ill. H. V. Loss (R A E J-Began March—1 part to date—30 cts).

MILITARY ENGINEERING.

10514. The Fontainebleau Proving Grounds. Ill. (Sc A-Feb. 18.) 2000 w.

†10550. The Uselessness of Gibraltar. W. Laird Clowes (F R-Feb.) 4000 w.

*10585. The Navy of the United States. H. W. Raymond (Ch-March) 3000 w.

*10619. Cordite. Editorial (Eng L-Feb. 10.) 1000 w.

10648. An Important Report upon Our New Navy, by Chairman Herbert (B I S-Feb. 22.) 1000 w.

10678. The New Armor Specifications (Ir Age-Feb. 23.) 3000 w.

†10716. Hawaii and Our Future Sea Power. A. T. Mahan (F-March.) 4800 w.

†11059. The Army Organization Best Adapted to a Republican Form of Government, Which Will Ensure an Effective Force. Sydney E. Stuart (J M S I-March.) 18,900 w.

†11060. Telegraph in War. Jas. A. Swift (J M S I-March.) 3200 w.

11081. Gun and Shell Making. James Eastus Price (M N-March 1.) 1500 w.

Serials.

8241. Assault and Battery. Ill. A. Ewbank (I E-Began Oct. 22—12 parts to date—45 cts. each).

9347. Notes of Lectures on Artillery in Coast Defense. A. C. Hansard (J M S I-Began Jan —2 parts to date—45 cts. each).

10738. The Development of American Armor-Plate. Ill. F. Lynwood Garrison (M-Began Feb. 15—1 part to date—30 cts).

10957. Chinese Curios. Consul Bedloe (A A-Began March 4—1 part to date—15 cts).

MINING.

10516. Dakota Tin Mines. Wilder Grahame (Min-Jan.) 1400 w.

10531. Spanish-American and Other Cuban Iron Mines. Ill. S. P. Ely (I T R-Feb. 16.) 3500 w.

10532. Wire Rope Tramway at the San Juan Mines. Ill. (E N-Feb. 16.) 800 w.

10556. Report of Inspector of Mines in West Virginia (M R-Feb. 17.) 600 w.

10560. Lead and Zinc Mines in the South. Ill. (T-Feb. 15.) 300 w.

10561. A Brief Golden Dream. Dan De Quille (E M J-Feb. 18.) 1000 w.

10562. Lead and Zinc Mining Industry of Missouri and Kansas in 1892. J. R. Holibough (E M J-Feb. 18.) 1100 w.

10563. The Mines of Sierra Mojada, Mexico. Eugene O. Fechet (E M J-Feb. 18.) 2500 w.

10564. Graduates of Mining Schools. Samuel B. Christy (E M J-Feb. 18.) 1900 w.

10565. The Persistence of Ores in Lodes in Depth.—The Empire Lode. H. M. Beadle (E M J-Feb. 18.) 300 w.

*10566. The Economic Geology of Tin. Ill. H. A. Wheeler (C E-Feb.) 1200 w.

*10571. The Best Types of Safety Lamps for Gas Testing Purposes. Ill. Alexander Dick (C E-Feb.) 800 w.

*10572. On Metal Mining. Ill. M. C. Ihlseng (C E-Feb.) 1000 w.

*10573. On Mining Machinery.—Hoisting Engines. F. W. Ewald (C E-Feb.) 1200 w.

10605. The Comstock Lode a Devourer of Forests. Ill. Dan De Quille (M I T-Feb. 16.) 1900 w.

*10624. Some Remarks on Wasted Coal. Walter J. May (C G-Feb. 10.) 1500 w.

*10642. The Mount Stewart Lead and Silver Mine (A M S-Jan. 7.) 1200 w.

*10643. Gold in Borneo.—A Field for Enterprise (A M S-Jan. 7.) 1500 w.

*10646. The White Cliffs Opal Field. (N. S. W.) John B. Jaquet (A M S-Jan. 21.) 2500 w.

10675. Where the Columbia River Gold Comes From. H. S. Back (M S P-Feb. 18.) 1000 w.

10714. The Gold Mining Industry of Nova Scotia in 1892 (E M J-Feb. 25.) 500 w.

10715. A Method of Transferring Surface Signment Underground. Ill. L. Kuhn (E M J-; eb. 25.) 500 w.

†10720. The Cost of Silver and the Profits of Mining. J. D Hague (F-March.) 3700 w.

10725. Phosphate Developments About Fort Meade. Nodule (M R-Feb. 24.) 1000 w.

*10743. The Coal Trade Crisis in South Wales. Editorial (I L-Feb. 17.) 1300 w.

*10783. Mexico an Iron Producing Country. Editorial (I C T-Feb. 17.) 1200 w.

*10787. The Syndicating of the Coal Industry (C G-Feb. 17.) 2000 w.

*10789. The Carmaux-Albi Coalfield, France. Jules Laromiguière (C G-Feb. 17.) 2000 w.

*10797. On the Detection and Estimation of Small Proportions of Fire-Damp, Petroleum Vapor, and Other Inflammable Gas or Vapor in the Air. Ill. Frank Clowes (J S A-Feb. 17.) 10,000 w.

10882. The Biwabik Mine. U. V. Winchell and John T. Jones (Ir Age-March 2.) 400 w.

10891. Mineral Wealth of Eastern Oregon. D. E. Cummins (M S P-Feb. 25.) 1250 w.

10907. Copper Mining in the South. Ill. James G. Parks (T–March 1.) 2000 w.

10908. Iron Deposits in Texas. W. J. Singletary (T–March 1.) 750 w.

10924. Tin in the Malay Peninsula.—Report of Consul Wildman (A M & I W–March 3.) 2100 w.

10967. Geological Occurrence of the Broken Hill Ore Deposits. Ill. E. F. Pittman (E M J–March 4.) 800 w.

10968. The Relation Between Ore Deposits and Their Inclosing Walls. Harold W. Fairbanks (E M J–March 4.) 1600 w.

11012. The Coal and Iron Resources of Texas. W. S. A. (M R–March 3.) 1200 w.

*11040. Mining Labor in the United States (C G–Feb. 24.) 1500 w.

*11041. Spontaneous Combustion in Coal Mines. Arnold Lupton (C G–Feb. 24.) 2500 w.

11097. An Abnormal Borax Deposit. Ill. (M S P–March 4.) 400 w.

Serials.

10232. The Present Status of Natural Gas in Ohio. Edward Orton (A M & I W–Began Feb. 3—Ended Feb. 17—3 parts—15 cts. each).

10584. Scientific Phases of Mining. Albert Williams, Jr. (Ch–Began March—1 part to date—30 cts).

10623. General Theory of Turbo-Engines, with Special Reference to Mine Ventilators. M. Rateau (C G–Began Feb. 10—2 parts to date—30 cts. each).

10645. Croydon (U. Q.) (A M S–Began Jan. 14—2 parts to date—30 cts. each).

10724. The Phosphate Mines of Canada. H. B. Small (M R–Began Feb. 24—2 parts to date—15 cts. each.

10978. The Lührig Process of Washing and Treating Coal. James I'Anson (I–Began Feb. 24—1 part to date—30 cts.

RAILROADING.

*10505. Would the Pan-American Road Pay? Ill. Charles P. Yeatman (E Mag–April.) 3000 w.

10511. English Locomotives and Railway Management. W. H. Booth (A M–Feb. 16.) 1400 w.

10518. Railroads Toward the North Pole (B I S–Feb. 15.) 700 w.

10527. Use of Streets for Railroad Purposes.—Rights of Abutting Property Owners. L. L. B. (S R N–Feb. 18.) 1300 w.

10536. The American Type of Freight Cars for European Railways (E N–Feb. 16.) 500 w.

10540. An English View of American Railways and Locomotives. Editorial and Letter (E N–Feb. 16.) 5000 w.

10549. The New Railway Rates. J. Stephen Jeans (F R–Feb.) 6500 w.

10555. An Important Railroad Project. (M R–Feb. 17.) 550 w.

10575. Trestles on the Norfolk and Western. Ill. Emile Low (R G–Feb. 17.) 550 w.

10576. The New Orleans Bridge (R G–Feb. 17.) 600 w.

10577. The Western Section of the Trans-Siberian Railroad. Michel Nicolaevich Ghercevanof (R G–Feb. 17.) 2300 w.

*10587. The Rezende Viaduct of Old Rails. Ill. (A J R A–Feb.) 200 w.

10595. Should Sleeping Car Rates Be Reduced. Editorial (R A–Feb. 17.) 900 w.

10596. Railway Companies and their Employés. O. D. Ashley (R A–Feb. 17.) 3800 w.

10597. New Sheep Pens.—C. B. & Q. Railroad. Ill. (R A–Feb. 17.) 1000 w.

*10598. The Los Angeles Consolidated Electric Railway. Ill. (S R R–Feb.) 2000 w.

*10599. The Broadway Cable.—The Most Difficult Enterprise Undertaken by a Street Railway. Ill. (S R R–Feb.) 3500 w.

*10601. A Chinese Cable Line. Ill. (S R R–Feb.) 700 w.

*10602. An Argument in Favor of Ground Plates as Against a Continuous Copper Return. J. F. E. (S R R–Feb.) 2000 w.

10603. Street Railways and the West (S R G–Feb. 20.) 1400 w.

10604. The Green Electric Railway Patents. Ill. (S R G–Feb. 20.) 1500 w.

10606. Safety-Couplers. W. M. Mitchell (R R–Feb. 18.) 1800 w.

10607. Care of Foundation Brakes. Jas. Howard (R R–Feb. 18.) 1850 w.

10609. The Storehouse System of the Chicago, Burlington and Quincy Railroad (R R–Feb. 18.) 1600 w.

10610. Interlocking and Block Signal System.—C. & N. W. Ry. (R R–Feb. 18.) 1500 w.

10611. Co-operation of Railway Managers and Railway Commissioners. Editorial (R R–Feb. 18.) 800 w.

10612. Safety Appliance Legislation, with Bills (R R–Feb. 18.) 2500 w.

*10613. The Lighting of Railway Trains. Ill. Harry Pollitt (P Eng–Feb. 10.) 2800 w.

*10620. English Locomotives in New South Wales. Ill. (Eng L–Feb. 10.) 800 w.

10652. Railways of Great Altitude in the Andes (Sc A S–Feb. 25.) 2600 w.

10663. Long Electric Railroads in Ohio (E E N Y–Feb. 22.) 1500 w.

10690. Special Train for the Emperor of Austria. Ill. (E N–Feb. 23.) 1200 w.

10693. Eight Years' Travel over Brooklyn Bridge (E N–Feb. 23.) 400 w.

10698. The Competitive Tests of the Westinghouse and New York Air Brakes on the N. Y. Central R. R. (E N–Feb. 23.) 6800 w.

10703. The West Albany Brake Trials, with Editorial (R G–Feb. 24.) 9000 w.

10704. The National Repeating Torpedo Signal. Ill. J. W. Lattig (R G–Feb. 24.) 2300 w.

10706. The Reading in the Hands of Receivers, with Editorial (R G–Feb. 24.) 2000 w.

10708. Blast Nozzles. Editorial (R G–Feb. 24.) 1300 w.

*10727. The Jaffa and Jerusalem Railway. Ill. Selah Merrill (Sc M–March.) 5700 w.

*10733. The Great Trans-Siberian Railway. Ill. Valerian Gribayédoff (Cos–March.) 4500 w.

10737. The Calumet Electric Railway. Ill. (S R G–Feb. 27.) 1000 w.

*10746. Electrical Block Interlocking Systems. R. Woods (I L–Feb. 17.) 1700 w.

10765. Rapid Transit in Boston.—Address of Henry M. Whitney (M G–Feb. 25.) 10,000 w.

10766. Rapid Transit. Editorial (M G–Feb. 25.) 600 w.

*10767. The Electric Railway to the Saleve near Geneva. Ill. (E L–Feb. 17.) 900 w.

*10782. The Shortlands and Nunhead Railways. Ill. A. G. Drury (Eng L–Feb. 17.) 4000 w.

10798. Railway Labor Organizations. Editorial and List (R A–Feb. 24.) 1600 w.

10799. Shortages in Railroad Accounts. E. P. Higgins (R A–Feb. 24.) 2800 w.

*10804 Heating Railway Carriages. Ill. (E–Feb. 17.) 1800 w.

10831. Railway Safety Appliances. H. S. Haines (R R–Feb. 25.) 2600 w.

10833. Heating Railway Cars in France (R R–Feb. 25.) 1000 w.

†10848. Denver and Its Street Railways. Ill. (S R J–March.) 1400 w.

10868. A Monster Locomotive. Ill. (Sc A–March 4.) 500 w.

10873. An Electric Headlight. Ill. (E N Y–March 1.) 2500 w.

10899. The Abt Rack Railway in Syria (E N–March 2.) 700 w.

10901. Shocks in Air Brake Tests (E N–March 2.) 1000 w.

10903. Statistics Showing the Track Laying of 1892, and the Prospective Railway Construction of 1893, with Map (E N–March 2.) 7300 w.

*10909. Cutting Eccentric Keyways Before Wheels Are Placed Under Engines. Ill. Fred S. Hill (L E–March.) 1500 w.

*10911. Improvements at the Pittsburg Locomotive Works. Ill. J. A. H. (L E–March.) 1600 w.

*10912. Compound and Simple Engines. Hugh Sharp (L E–March.) 1300 w.

*10913. Setting Up Wedges, Keying Side-Rod Brasses, and Tramming Engines. G. K. W. (L E–March.) 1200 w.

*10914 The Brazilian Central Railway. Lewis Gleason (L E–March.) 1800 w.

*10915. The Greater Santa Fé Trail. A. S. (L E–March.) 2000 w.

10935. The Possibilities of Fraud in Present Systems of Freight Accounting. A. D. Oyer (R A–March 3.) 1200 w.

10936. Two Cents per Mile in Missouri. W. C. Brown (R A–March 3.) 2500 w.

10962. Wheel Gage Limits. Editorial. Ill. (R M M–March.) 1500 w.

10963. The Use of Compressed Air in Railroad Shops. Ill. F. M. Twombley (R M M–March.) 1000 w.

10964. Tests of Locomotives in Heavy Express Service. Ill. William Forsyth (R M M–March.) 2000 w.

10965. Oil Furnace for Blacksmith Shops.—Pittsburgh, Cincinnati, Chicago and St. Louis R. R. Ill. (R M M–March.) 800 w.

*10974. Railway-Carriage Warming in England. Ill. (I–Feb. 24.) 2000 w.

*10982. Electrical Railways.—Abstract of paper by Edward Hopkinson (I C T–Feb. 24.) 1100 w.

*11003. The Railways and the Public. Editorial (I L–Feb. 24.) 3500 w.

11005. A Criminal Structure. Ill. Quintin McNab (R R–March 4.) 1200 w.

11006. Signaling Plant on the New York, New Haven and Hartford Railroad. Ill. (R R–March 4.) 700 w.

11008. The Law Governing the Application of Railway Safety Appliances (R R–March 4.) 800 w.

11009. Synopsis of the New German Railway Regulations (R R–March 4.) 1200 w.

*11017. Electric Lights for Railway Signals. Ill. (E I–March.) 1300 w.

11021. Northern Pacific Affairs.—Letter from "A Stockholder" (R G–March 3.) 1000 w.

11022. A Defect in Organization—Letter from L. E. H. (R G–March 3.) 1200 w.

11023. The Dangers of Oil Transportation. Senex (R G–March 3.) 1000 w.

11026. The Reading Receivership. Editorial (R G–March 3.) 1300 w.

11027. "A Defect in Railroad Organization." Editorial (R G–March 3.) 1400 w.

11029 The Adventures of a Way-Bill. Thomas Coam (R G–March 3.) 1700 w.

*11043. Progress of Cable Traction. Editorial (Inv–Feb. 25.) 3000 w.

11047. The "Vulcanizing" Process for Preserving and Strengthening Poles, Cross-Arms, Ties, etc. H. C. Myers (E A–March 4.) 700 w.

*11048. Facts Concerning the Siemens Electric Railway of the Year 1879. A. M. Tanner (E R L–Feb. 24.) 1000 w.

*11054. Tube-Frame Goods Wagon. Ill. M. R. Jefferds (R W–Feb.) 2800 w.

*11055. Railway Freight Rates in England and America. M. R. Jefferds (R W–Feb.) 1400 w.

11092. The Monte-Generoso Rack Railway. (E N–March 9.) 450 w.

11093. Uniformity in Freight Car Draft Gear (E N–March 9.) 2500 w.

Serials.

5219. The $350,000 Cable Road and the $46,000 Electric Road. Cable Railways (S R J–Began July—5 parts to date—45 cts. each).

9739. New Railways in Spain. Ill. (I L-Began Jan. 6—2 parts to date—30 cts. each).

10111. The Liverpool Overhead Railway. Ill. (E E L-Began Jan. 20—Ended Feb. 10—3 parts—30 cts. each).

10378. The Evolution of the Railroad Turntable. Ill. C. A. Greenleaf (R G-Began Feb. 10—2 parts to date—15 cts. each).

10446. Permanent Way for Viaducts. Ill. Herbert Tatham Procter (R R-Began Feb. 11—Ended March 4—2 parts—15 cts. each).

*10502. English and American Railways. Wm. M. Acworth (E Mag-Began April—1 part to date—30 cts).

10709. Strikes or No Strikes (R G-Began Feb. 24—2 parts to date—15 cts. each).

11007. Transcontinental Railways. Edward P. Vining (R R-Began March 4—1 part to date—15 cts).

SANITARY ENGINEERING.

10694. The Effect of Frost on the Sewage Filtration Beds at South Framingham, Mass. (E N-Feb. 23.) 650 w.

10696. The Use of Sewage for Irrigation in the West. Editorial (E N-Feb. 23.) 1400 w.

10728. Plumbing for a City House. Ill. (Met W-Feb. 25.) 2300 w.

10755. Heating and Ventilation of a Baltimore Church. Ill. (E R-Feb. 25.) 1800 w.

†10905. The Need of Sanitary Supervision of Schools. Jerome Walker (San-March) 6000 w.

*10921. Notes on Sewage and Sewers. Louis H. Gibson (P-March) 1800 w.

10944. Importance of Pure Water. Henry Stewart (Am A-March.) 1300 w.

10973. The Dangers of City Refuse (Eng-March 4.) 1300 w.

Serials.

5358. Sewage Purification in America (E N-Began July 14—23 parts to date—15 cts. each).

8127. Ventilation and Heating. John S. Billings (E R-Began Nov. 19—4 parts to date—15 cts. each).

10425. A Healthy Home. Francis Vacher (S R-Began Feb. 1—2 parts to date—30 cts. each).

10557. Sewage Treatment and Sludge Disposal. W. Santo Crimp (E R-Began Feb. 18—Ended March 4—3 parts—15 cts. each).

10641. Purifying Water for Household Supply (S P-Began Feb. 15—1 part to date—15 cts).

10942. The New York Plumbing Regulations. Arthur Howell Napier (E R-Began March 4—1 part to date—15 cts).

STEAM ENGINEERING.

10521. Marine Engines on Land (S V-Feb. 15.) 1000 w.

10546. Spring Safety Valves (S E-Feb. 11.) 1000 w.

10547. Inspection and License Law. John A. Davis (S E-Feb. 11.) 900 w.

*10570. Cylindrical Boilers.—A Successful Plan for Increasing Their Efficiency. Ill. James Pollock (C E-Feb.) 1600 w.

*10589. Grates (A J R A-Feb.) 1500 w.

10594. Setting Engine Valves. Ill. (B J C-Feb. 18.) 2300 w.

*10621. The Mystery of Steam. Letters of Robert Mansell and William Donaldson (Eng L-Feb. 10.) 2000 w.

10705. Some Thoughts on Boiler Inspection. John Hickey (R G-Feb. 24.) 1400 w.

10762 The Steam Engine Indicator, Applied to an Unevenly Balanced Engine (B J C-Feb. 25.) 650 w.

10763. Boiler Feed Pipes (B J C-Feb. 25.) 1000 w.

10764. Steam Power's Discoverer.—The Painful Story of Samuel Caus (B J C-Feb. 25.) 600 w.

*10790. Winding Engines (C G-Feb. 17.) 1800 w.

*10826. Hot Water Storage. W. H. Booth (E R L-Feb. 17.) 1000 w.

10879. Deterioration of Condenser Tubes in the United States Steamship "Baltimore" (Ir Age-March 2.) 1800 w.

10886. Waste Steam Injectors. W. H. Booth (A M-March 2.) 1300 w.

*10910. Heat and Combustion. Angus Sinclair (L E-March.) 2800 w.

*10916. Manipulating Boiler Plates (L E-March.) 900 w.

10940. Flue Temperatures as Affected by Firing. Ill. David M. Greene (E R-March 4.) 450 w.

10950. The Strength of Shafting (B J C-March 4.) 1200 w.

10951. Steel Boiler Tubes.—Will They Supersede Iron? (B J C-March 4.) 700 w.

10952. A Corliss Valve Trouble. Ill. (B J C-March 4.) 500 w.

10972. Sequence of Cylinders and Cranks in Triple Expansion Marine Engines. W. J. Winterburn (Eng-March 4.) 1500 w.

11071. Injector Notes—Ejector Condensers. W. H. Booth (A M-March 9.) 1500 w.

Serials.

7456. The Locomotive Boiler. Ill. Gustav Richard (A J R A-Began Oct.—4 parts to date—30 cts. each).

10664. Apparatus for Determining the Amount of Water in Steam. W. R. Cummins (I L-Began Feb. 10—Ended Feb. 17—2 parts—30 cts. each).

10681. Compound Expansion Engines (Ir Age-Began Feb. 23—1 part to date—15 cts).

10726. The Development of the Steam Engine (M R C-Began Feb. 23—2 parts to date—15 cts. each).

10946. Hints. W. H. Wakeman (M G-Began March 4—1 part to date—15 cts).

11001. Thermodynamic and Adiabatic Diagrams of Water and Steam. Ill. R. H. Smith (I L-Began Feb. 24—1 part to date—30 cts).

11085. The Causes of Corrosion in Steam Boilers. William H. Edgar (S E-Began March 4—1 part to date—15 cts).

TELEPHONY AND TELEGRAPHY.

10512. The Crowning Achievements of the Telephone (Sc A-Feb. 18.) 1000 w.

10519. The Death of Dr. Norvin Green. Ill. (E W-Feb. 18.) 800 w.

*10529. One Use for the Telephone. Ill. F. S. Marsh (E E L-Feb. 3) 900 w.

10649. The Berliner Microphone Patent. Editorial (Sc A-Feb. 25.) 1400 w.

10680. The Submarine Cable Systems of the World (Ir Age-Feb. 23) 100.0 w.

10702. Berliner Telephone Litigation. Editorial (W E-Feb. 25.) 2800 w.

*10768. The Latest Telegraph Statistics (E L-Feb. 17.) 400 w.

10819. The Telephone.—Its Legal History and Commercial Condition Presented by a Master Hand. Grosvenor P. Lowry (E R N Y-Feb. 25.) 3500 w.

10822. Telephone Improvement (E R N Y-Feb. 25.) 950 w.

*10828. The Chin Column Telegraph Expedition. F. E. Dempster (E R L-Feb. 17.) 4200 w.

10839. The Famous Bell Patent. Ill. (E R N Y-March 4.) 3000 w.

*11051. An Improved Telephone Switchboard System. Ill. (E R L-Feb. 24.) 1100 w.

Serials.

6515. Notes on Submarine Cable Work. Ill. H. D. Wilkinson (El-Began Sept. 2—Ended Feb. 17--10 parts--30 cts. each).

10285. Inaugural Address of W. H. Preece (E E L-Began Jan. 27--Ended Feb. 3—2 parts—30 cts. each).

10470. The Theory of Submarine Cable Laying. G. W. Littlehales (E E N Y-Began Feb. 15—Ended Feb. 22—2 parts--15 cts. each).

10669. The Telephone Situation (E W-Began Feb. 25—2 parts—15 cts. each).

MISCELLANEOUS.

*10501. A Decade of Marvelous Progress. R. H. Edmonds (E Mag-April.) 3000 w.

*10506. Refrigeration from Central Stations. John E. Starr (E Mag-April.) 3000 w.

*10507. Conditions of Forestry as a Business. W. J. Beal (E Mag-April.) 3000 w.

*10508. An Early Engineering Magazine. Hyland C. Kirk (E Mag-April.) 3000 w.

*10509. The Past and Future of Engineering. Gordon B. Kimbrough (E Mag-April.) 3000 w.

10515. Motors for Aerial Machines. Abstract from a Lecture by O. Chanute (Sc A S-Feb. 18.) 2500 w.

10522. Will We Navigate the Air? Ill. Hiram Maxim (S V-Feb. 15.) 3000 w.

†10581. Commercial Unity with the Colonies. Augustus Loftus (N C-Feb.) 3000 w.

*10617. Municipal Contracts. Alfred H. Gibbings (E R L-Feb. 10.) 1600 w.

*10626. The Wiborgh Luft (Air) Pyrometer. Emanuel Trotz (C G-Feb. 10.) 1500 w.

10655. Attacks on City Parks (G & F-Feb. 22.) 1200 w.

*10685. The Onyx Deposits of Cave Creek, Arizona. George P. Merrill (S-Feb.) 700 w.

10690. The Art of To-day. C. F. A. Voysey (A & B Feb. 25.) 2200 w.

†10719. The Science of Municipal Corruption (F-March.) 4000 w.

†10722. An Appeal to Retire Government Paper Money. M. Brühl (F-March.) 2200 w.

*10732. In Our Cotton Belt. Ill. H. S. Fleming (Cos-March.) 4500 w.

*10734. An Italian Campo Santo. Ill. Murat Halstead (Cos-March.) 3500 w.

10754. The Status of the Engineering Profession. H. F. J. Porter (E R-Feb. 25.) 900 w.

10760. Brief Historical Review of the Lakes and Gulf Waterways. J. R. Leighty (R T-Feb.) 1200 w.

10777. The Downfall of the Hawaiian Monarchy. William T. Brigham (B C-Feb. 25.) 1800 w.

*10796. On Pottery Glazes: Their Classification and Decorative Value in Ceramic Design. Ill. Wilton P. Rix (J S A-Feb. 17.) 1300 w.

*10805. The Commercial Aspect of an Engineer's Training. Editorial (E-Feb. 17.) 1200 w.

*10809. The Future of Sculpture (A L-Feb. 17.) 2000 w.

†10850. American Farming A Hundred Years Hence. J. M. Rusk (N A R-March.) 2800 w.

†10851. The Sandwich Islands.—I. The Advantages of Annexation. Lorrin A. Thurston. II. Is It Constitutional? George Ticknor Curtis (N A R-March.) 8200 w.

†10852. Modern Insurance and Its Possibilities. R. A. McCurdy, J. L. Greene, Sheppard Homans, and Clarence H. Kelsey (N A R-March.) 7200 w.

†10854. England in the Orient. Arminius Vambery (N A R-March.) 2000 w.

†10855. National Banking and the Clearing House. A. B. Hepburn (N A R-March.) 4200 w.

*10856. America in Hawaii. Ill. Sereno Bishop (R of R-March.) 4800 w.

*10857. England in Egypt. Ill. (R of R-March.) 6300 w.

10867. The Manufacture of Dynamite. Ill. Maxime Vuillaume (Sc A-March 4.) 2000 w.

10876. The Principles of Economic Legislation. Edward A. Ross (P A-March 1.) 1600 w.

*10896. The Recent Survey in St. Louis.—Its Methods and Results. Ill. B. H. Colby (J A E S-Jan.) 14.000 w.

10904. Asphalt Pavements.—How They Should Be Cleaned (E N-March 2.) 2600 w.

10919. Some Causes of Failure of Heating

We supply cost of these articles. See Introductory.

Apparatus. Franklin Van Winkle (A Ar–March 4.) 1700 w.

10925. The Fuel Question. Editorial (A M & I W–March 3.) 1000 w.

10937. "The Status of the Engineering Profession." Peter Milne (F W–March 4.) 900 w.

10941. Test of a Hot Water Heating Plant. Ill. (E R–March 4.) 3000 w.

10947. Value of Spruce Forests. Editorial (M G–March 4.) 1100 w.

10948. The Distinction Between the Patent Systems of the United States and Those of Other Countries. A. Steuart (I Age–March.) 3800 w.

10949. On the Wing.—Imitation of Birds and Insect Flight. Ill. Si. O. Bud (I Age–March.) 500 w.

10953. The Fuel Oil Plant at the Columbian Exposition. Ill. (P S–March.) 2200 w.

11011. Engineering Progress. Alfred E. Hunt (R R–March 4.) 1600 w.

11014. Perpetual Motion Infatuation. Editorial (M R–March 3.) 900 w.

11030. Carelessness in Pipe Fitting (Met W–March 4.) 3500 w.

11032. An Aboriginal Soapstone Quarry (M & B–Feb.) 1000 w.

11095. The Use of Burlap for Levee Protection During High Water. E. J. Chamberlain (E N–March 9.) 800 w.

Serials.

9401. World's Columbian Exposition (E N–Began Jan. 5—3 parts to date—15 cts. each).

9519. Municipal Equipment and Engineering of Paris Jas. W. Howard (P–Began Jan.—Ended March—3 parts—30 cts. each).

9745. American Industries and British Commerce (E–Began Jan. 6 - 6 parts to date—30 cts. each).

9851. The Glass Industry. Ill. C. Hanford Henderson (P S M–Began Feb.—Ended March—2 parts—45 cts. each).

10490. The Diffusion of Light. W. E. Sumpner (El–Began Feb. 3—Ended Feb. 17—3 parts—30 cts. each).

10535. Notes from the Engineering Schools (E N–Began Feb. 16—3 parts to date—15 cts. each).

NEW BOOKS OF THE MONTH.

(For the convenience of readers any American books will be supplied at publishers' prices by The Engineering Magazine Co. Foreign books, 25 per cent. extra.)

Abbe, Cleveland.=The Mechanics of the Earth's Atmosphere: A collection of translations. Washington, D. C.: Smithsonian Institution. [Paper, 327 p.]

Bankson, Lloyd.=Slide-Valve Diagrams: A French Method of Obtaining Slide-Valve Diagrams. New York: D. Van Nostrand Co. [16mo, boards, 50c.]

Baye, J. de.=The Industrial Arts of the Anglo-Saxons: From the French, by T. B. Harbottle. New York: Macmillan. [Folio, cloth, 181 p., $7.]

Bedell, Frederick, and Crehore, Albert C.=Alternating Currents: An Analytical and Graphical Treatment for Students and Engineers. New York: W. J. Johnston Co. [8vo, 325 p., $2.50.]

Bonney, G. E.=Electrical Experiments: A Manual of Instructive Amusement. New York: Macmillan. [12mo, cloth, 265 p., 75c.]

Bottone, S. R.=How to Manage the Dynamo; A handbook for ship engineers, electric light engineers, and electro-platers. New York: Macmillan. [12mo, cloth, 65 p., 60c.]

Gilbert, W.=On the Lodestone and Magnetic Bodies, and on the Great Magnet of the Earth: a translation by P. Fleury Motlelay. New York: Wiley. [8vo, cloth, 384 p., $4.]

Gray, Andrew.=The Theory and Practice of Absolute Measurements in Electricity and Magnetism. New York: Macmillan. [12mo, cloth, $6.25.]

Hett, C. L.=The Turbine Manual and Millwright Handbook. New York: Spon. [8vo, paper, 80c.]

Hiles, Theron L.=The Ice Crop: how to harvest, store, ship, and use ice. New York: Orange Judd Co. [12mo, cloth, 125 p., $1.]

Infantry Drill Regulations, U. S. Army;—With Interpretations of 250 Pars: by the Recorder of the Tactical Board. New York: Army and Navy Journal. Appleton. [32mo, paper, 398 p., 30c.]

Jeffrey Manufacturing Co., Columbus, O.=Elevating and Conveying Machinery. A new catalogue for 1893, elaborately illustrated and so replete with tabulated statistics and practical information that it may rightly be called a textbook covering the whole broad field. [8vo, paper, 260 p., free on application to the firm.]

Kundsen, Augustus. = Triangular Surveys from Single Stations. San Francisco: Brunt & Co. [32mo, paper, 32 p., $1.]

La Rue, B. F.=A Graphical Method for Swing-Bridges. New York: D. Van Nostrand Co. [16mo, boards, 50 cts.]

Nasmith, Jos.=Students' Cotton Spinning. New York: D. Van Nostrand Co. [12mo, cloth, $3.]

Reece, Benjamin.="Railway Specialties." Vol. I. No. 1. A humorous periodical, modeled after "Life"; elaborately and takingly illustrated, and designed for the entertainment of railroad men, while at the same time making known the virtues of certain railway appliances. An original and striking publication which every railroad man should possess. [Sent free on application. The Q. & C. Co., Chicago–New York.]

Water Tower, Pumping and Power Station Designs: The Engineering Record's 34 Prize Designs. [4to, cloth, $2.]

ARCHITECTURE.

*11099. Ethics of Architectural Competitions. John M. Carrère (E Mag–May.) 3000 w.

*11204. Suggestions for Designs from Foliage. The Linden. Ill. H. Leslie Ramsey (Pl D–March 1.) 1200 w.

*11205. Taste, Fancy, and Education in Color. Arthur S. Barbier (Pl D–March 1.) 1300 w.

*11213. Wall-Papers and Stenciling, with Discussion. Ill. T. R. Spence (J S A–March 3.) 10,000 w.

*11238. Renaissance Architecture in England. J. Alfred Gotch and W. Talbot Brown (A L–March 3.) 2700 w.

*11239. The Influence of Art. Holman Hunt (A L–March 3.) 2000 w.

*11240. Originality and Individuality in Art. Arthur Street (A L–March 3.) 8400 w.

*11241. The Woods and the Architecture of Bath. R. E. Peach (A L–March 3.) 1200 w.

*11266. The Strength of Cast Iron Columns (I & S–March 4.) 1200 w.

11329. Roofing (R & T–March.) 2000 w.

11330. Roofs—Their Construction and Care (R & T–March.) 700 w.

11348. Something About Chimneys. Ill. Oscar E. Perrigo (A M M–March.) 1000 w.

*11403. Straight Heads or Flat Arches. Ill. (A L–March 10.) 1500 w.

*11422. For and Against Terra Cotta. "The Man in the Street" (B A–March 10.) 1200 w.

*11430. Some Observations on Fireproof Building in New York. Ill. John C. B. Horwood (Can A–March.) 4200 w.

*11431. Joints in Carpentry (Can A–March.) 1200 w.

*11432. The Place of Architecture in National History. G. F. Stalker (Can A–March.) 2400 w.

11443. A Study of Architecture in the Rural Districts of the West. Ill. Thomas Holmes (G & F–March 22.) 600 w.

*11475. Anne of Brittany's Châteaux in the Valley of the Loire. Ill. Theodore Andrea Cook (Sc M–April.) 6000 w.

11496. Freezing Test for Building Stone (E N–March 23.) 650 w.

*11526. Thoughts on Architecture: Its Literature and Practice. George C. Mason (J A–Feb.) 4400 w.

11540. A New Fireproof Construction. Ill. N. Poulson (A A–March 25.) 1600 w.

*11572. The Action of Frost upon Building Stones. Editorial (Eng L–March 17.) 1600 w.

*11580. St. John, Syracuse, Italy. Ill. (A L–March 17.) 700 w.

*11630. Potsdam Red Sandstone. Ill. (S–March.) 2500 w.

*11631. Miracles in Marble. Clement Scott (S–March.) 2200 w.

11637. The Selection of Building Stone. Editorial (E N–March 30.) 3500 w.

11690. Mill-Construction:—What It Is, What It Is Not. Edward Atkinson (A A–April 1.) 2000 w.

*11726. The Palace of Theodoric at Ravenna. Ill. (A L–March 24.) 1600 w.

*11727. The Language of Architecture. Abstract of Lecture by C. R. Ashbee (A L–March 24.) 900 w.

11781. The New Hotel Waldorf. Ill. (E W–April 8.) 2000 w.

*11789. The Modern Architect and His Relations to the Builder (N W–March.) 1300 w.

11813. Glafcke's Improvement in Prison Construction. Ill. (Sc A–April 8.) 1000 w.

†11827. Man and His Art—An Architectural Point of View. Ill. Irving K. Pond (I A–March.) 3800 w.

†11828. Chicago Building Ordinance Revision. Dankmar Adler (I A–March.) 800 w.

*11829. Fences and Enclosures. Edward Hurst Brown (B & D–March.) 1700 w.

Serials.

2285. Construction. Ill. M. Viollet-le-Duc (A A–Began Feb. 20, 1892—20 parts to date—15 cts. each).

7121. Office-Help for Architects. Ill. George Hill (A A–Began Oct. 8—8 parts to date—15 cts. each).

10673. Architectural Terra-Cotta. Ill. (B B–Began Jan.—2 parts to date—30 cts. each).

10682. The Châteaux of France. Ill. Louis H. Gibson (S–Began Feb.—2 parts to date—30 cts. each).

10960. The Origin of Building. Howell J. Williams (A & B–Began March 4—Ended March 18—3 parts—15 cts. each).

11136. A Distinction in the Acoustic Purposes of Public Buildings. H. C. Kent (A & B–Began March 11—2 parts to date—15 cts. each).

11170. Architecture of the Low Countries. J. Van Ysendyck (A A–Began March 11—4 parts to date—15 cts. each).

11379. How to Build a Factory (T–Began March 15—2 parts to date—15 cts. each).

CIVIL ENGINEERING.

*11106. The Care of Existing Highways. W. E. McClintock (E Mag–May.) 3000 w.

*11192. The Proposed Bruges Ship Canal. Ill. (E–Jan. 27.) 2100 w.

*11210. Novel Bascule Bridge for the East. Ill. (I L—March 3.) 700 w.

*11214. Bridging the Bosphorus. Ill. James Garvie (Eng L–March 3.) 4000 w.

†11256. Borings in Broadway, New York, with Discussion. Ill. William Barclay Parsons (T C E–Jan.) 2400 w.

*11267. Canadian Canals (I & S–March 4.) 700 w.

11291. Improvements in Boston Harbor. Ill. (Sc A–March 18.) 900 w.

11313. Concerning Highway Bridges. Charles F. Stowell (E N–March 16.) 1300 w.

11315. Bridge Building Opinion.—A Bit of History (E N-March 16.) 1300 w.

11377. The Control of the Mississippi River —A Plan Whereby Its Banks Can Be Protected. Ill. (T-March 15.) 2500 w.

†11401. The Sarunda Tunnel, Bengal-Nagpur Railway. Ill. W. M. Moylan (I E-Feb. 18.) 800 w.

*11408. The Subsidence at Sandgate (Eng L-March 10.) 1100 w.

11485. Concrete Highway Bridge in Germany. Ill. (E N-March 23.) 350 w.

11529. Method of Erecting the Iritty Bridge, Malabar. Ill. (R G-March 24.) 900 w.

11591. The Best Practical Methods of Constructing Hard Roads (E R-March 25.) 1000 w.

11633. The New Palisades Tunnel. Ill. (E N-March 30.) 2000 w.

11634. A Specimen of British Bridge Construction. Ill. (E N-March 30.) 700 w.

11665. Cox's Earthwork Computer (R G-March 31.) 800 w.

11698. The East River Bridges. Editorial (E R-April 1.) 750 w.

*11777. The Nicaragua Canal Project.—How It Stands and What Is Done (Tr-March 24.) 2700 w.

11798. Natural and Artificial Cements in Canada. H. P. Brumell (Sc-March 31.) 800 w.

*11814. Trinidad Asphalt Deposits. D. Torrey (P-April.) 2800 w.

11845. The Coming Pavement Brick (M R-April 7.) 1000 w.

Serials.

9523. Maintenance of Roads in France. Arthur Lagron (P-Began Jan.—Ended April—4 parts—30 cts. each).

10455. The Bridges of the Manchester Ship Canal. Ill. (E-Began Feb. 3—4 parts to date—30 cts. each).

11182. The Nicaragua Canal. Ill. (E-Began Feb. 24—3 parts to date—30 cts. each).

11201. On the Breach in the Embankment of the Yellow River. Ill. G. James Morrison (E-Began March 3—Ended March 10—2 parts—30 cts. each).

11209. The Maritime Gateway to the Pacific. B. H. Thwaite (I L-Began March 3—Ended March 17—3 parts—30 cts. each).

ELECTRICAL MISCELLANY.

11133. The Future of Electricity. A. E. Dolbear (M G-March 11.) 3600 w.

*11143. How Can the Department of Electricity of the World's Columbian Exposition Best Serve the Electrical Interests?—The $50 Prize Essay. Nelson W. Perry (W F E E-March.) 3000 w.

*11144. How Can the Department of Electricity of the World's Columbian Exposition Best Serve the Electrical Interests?—The $25 Prize Essay. W. Clyde Jones (W F E E-March.) 2200 w.

*11145. Rules Governing the Supply of Lighting and Power to Exhibitors in the Department of Electricity (W F E E-March.) 1200 w.

*11186. Gilbert's "De Magnete"—A Review of Mr. Mottelay's Translation (E-Feb. 24.) 2700 w.

*11188. The Practical Measurement of Alternating Electric Currents. J. A. Fleming (E-Feb. 24.) 1500 w.

*11200. The Development and Transmission of Power from Central Stations. W. C. Unwin (E-March 3.) 4400 w.

*11234. What Is a Dynamo Machine? J. A. Kingdon (El-March 3.) 900 w.

*11235. Bovet Magnetic Adhesion Apparatus. Ill. R. V. Picou (El-March 3.) 1000 w.

*11237. The Theory of Dielectrics. A. Hess (El-March 3.) 600 w.

*11243. Who Discovered the Ratio of Transformers? Rankin Kennedy (E R L-March 3.) 250 w.

*11244. The History of Liquid Insulators. A. M. Tanner (E R L-March 3.) 1000 w.

11268. Attraction of a Hemispherical Shell in a Unit Quantity of Matter at Its Center. S. T. Moreland (E R N Y-March 18.) 400 w.

11269. A Curious Action of Attraction by Alternating Currents. Ill. Elihu Thompson (E W-March 18.) 450 w.

11272. On the Current Strengths in Simple Circuits Containing Resistance and Inductance under Periodic Impressed Electromotive Forces of the Rectangular Wave Type. A. E. Kennelly (E W-March 18.) 700 w.

11288. Interesting Electrical Experiments (Sc A S-March 18.) 3200 w.

11318. Notes on Lightning Protection. Ill. Alexander Jay Wurts (E E N Y-March 15.) 1500 w.

11319. An Ampere Foot Table. G. T. Evans (E E N Y-March 15.) 1200 w.

11326. Electric Stations as Insurance Risks. George P. Low (W E-March 18.) 6200 w.

*11405. The Effects of Mechanical Stress on the Electrical Resistance of Metals. James A. Gray and James B. Henderson (E E L-March 10.) 700 w.

*11426. Concentric Cable Phenomena in Alternate Current Working. Ill. L. Neustadt (El-March 10.) 1300 w.

*11429. Is Electrical Legislation Necessary or Even Advisable? Editorial (E L-March 10.) 1300 w.

11444. Non-synchronous Motors for Ordinary Alternating Circuits. Ill. E. Arnold (E E N Y-March 22.) 1900 w.

11446. Experiments with High Frequency Electric Discharges. A. A. C. Swinton (E E N Y-March 22.) 750 w.

11452. Nikola Tesla.—A Psychological and Scientific Study of the Man. Ill. J. A. M. (E R N Y-March 25.) 1800 w.

11473. The Influence of Electricity as an Educator (A B M-March.) 650 w.

11474. Water Flow and Electricity (A B M–March.) 700 w.

11481. The Electric Curtain of the Comedie Française. Ill. (Sc A S–March 25.) 600 w.

11482. Electrical Development in Japan in 1892. S. Katogi (E A–March 25.) 900 w.

11483. Tesla's Electrical Feats (P E–March 18.) 900 w.

11541. Reynolds' Instructions for Erecting and Testing Lightning Conductors (A A–March 25.) 3300 w.

11542. Attempts at Diamond Making. Ill. (W E–March 25.) 800 w.

*11552. Primary Batteries. Ill. (E R L–March 17.) 1600 w.

*11554. Electrical Engineering and Courtesy. Sydney F. Walker (E R L–March 17.) 1000 w.

*11562. The Design of Transformers and Choking Coils. James Whitcher (El–March 17.) 2200 w.

*11563. A Null Method of Measuring Specific Induction Capacity of Conducting Liquids. F. Heerwagen (El–March 17.) 200 w.

*11565. Oscillographs for the Investigation of Slow Electric Oscillations. Ill. A. Blondel (El–March 17.) 900 w.

11603. Electricity in a Modern Club. Ill. (E W–April 1.) 1800 w.

11606. A Plea for Abbreviations and Greater Distinctiveness in Electrical Terms. W. E. Ayrton (E W–April 1.) 1500 w.

*11611. An Electrically Driven Flour Mill (R M–March.) 500 w.

11616. Non-synchronous Motors for Ordinary Alternating Currents.—A Reply to Mr. C. E. L. Brown (E E N Y–March 29.) 500 w.

11617. Electric Motors Operating in Single Phase Alternating Current Circuits. Elias E. Ries and G. J. Scott (E E N Y–March 29.) 500 w.

11641. The Maximum Electric Current. W. J. Humphreys (Sc A–April 1.) 600 w.

11660. Present Status of the Storage Battery. J. K. Pumpelly and C. Sorley (W E–April 1.) 1600 w.

*11729. The Efficiency and the Advantages of Accumulator Batteries (E L–March 24.) 700 w.

*11771. Efficiency of Dynamo-Electric Machines. Ill. E. Wilson (E–March 24.) 1500 w.

*11772. A Hysteresis Theory of Brown's Alternating Current Motor. Ill. J. A. Kingdon (El–March 24.) 1500 w.

11779. The Grave of Benjamin Franklin. Ill. (E W–April 8.) 500 w.

11796. Weston Electrical Measuring Instruments. Ill. (E R N Y–April 8.) 2500 w.

11800. The Most Economical Boiler and Engine for Central Stations. J. A. Farlinger (C E N–April.) 4500 w.

11833. Electric Bolt Operating Mechanism for Safes. Ill. (W E–April 8.) 900 w.

11834. Electrical Development Abroad (W E–April 8.) 1700 w.

11837. Experience with Electrical Subways n New York (E N–April 6.) 3000 w.

11840. Putting Electric Wires Under Ground. Editorial (E N–April 6.) 1700 w.

Serials.

8905. Sparking at Commutators. Ill. F. M. Weymouth (El–Began Dec. 7—Ended March 17—8 parts—30 cts. each).

9713. Alternating Current Apparatus. C. Kammeyer (W F E E–Began Jan—Ended March —3 parts—30 cts. each).

10170. Electrical Oscillations of High Frequency. Ervin S. Ferry (E W–Began Feb. 4—Ended March 18—4 parts—15 cts. each).

10600. Electrical Measurements. Ill. George D. Shepardson (S R R–Began Feb.—2 parts to date—30 cts. each).

10659. Influence of Frequency in the Working of Alternate Current Transformers. Ill. Charles Steinmetz (E E N Y–Began Feb. 22—3 parts to date—15 cts. each).

10843. Conductors and Insulators. Ill. Reginald A. Fessenden (E W–Began March 4—3 parts to date—15 cts. each).

10995. On Testing and Working Alternators. Ill. W. M. Mordey (E E L–Began Feb. 24—Ended March 3—2 parts—30 cts. each).

11046. Some Experiences with the Alternating System. R. H. Sterling (E A–Began March 4—2 parts to date—15 cts. each).

11129. Some Principles That Must Be Observed in Order to Make a Good Closed Circuit Battery, and a New Portable Dry Cell Described in which These Principles Are Applied. E. F. Northrup (J F I–Began March—2 parts to date—45 cts. each).

11501. Theory of the Transformer. Ill. F. Bedell and A. C. Crehore (E W–Began March 25—2 parts to date—15 cts. each).

11560. Electricity as a Motive Power. Albion T. Snell (El–Began March 17—1 part to date—30 cts).

ELECTRIC LIGHTING.

11109. The Incandescent Lamp. Jas. A. Lightipe (P L–March 2.) 2400 w.

*11225. Electric Lighting Schemes for Strassburg (E E L–March 3.) 1600 w.

†11302. Comparison of Cost of Electric Lighting of Columbia College by Separate Plant and by Contract with Companies. W. W. Reese and Archibald Anthon (S M Q–Jan.) 1000 w.

11324. Electric Installations and Some Radical Changes in General Systems of Wiring. Ill. Charles G. Armstrong (W E–March 18.) 3500 w.

11325. Development of the Incandescent Lamp. Edward Weston (W E–March 18.) 6000 w.

*11404. Lighting by Phosphorescent Tubes. Ill. (E E L–March 10.) 2000 w.

11445. The von der Kammer Incandescent Lamp. Ill. (E E N Y–March 22.) 300 w.

11448. Search Light Projectors—An Experimental Comparison of the Mangin and Schuckert Projectors. M. Burstyn (E E N Y–March 22.) 2500 w.

11449. The "Incandescent Arc" Lamp as a Rival to the Incandescent Lamp. A. Noll (E E N Y–March 22.) 1600 w.

11450. A Compact Plant. The Electrical Equipment of the Havemeyer Building. Ill. (E N Y–March 22.) 800 w.

11451. *The Incandescent Lamp from a Commercial Standpoint. Edward Weston (E N Y–March 22.) 7000 w.

11500. The Incandescent Lamp Situation.—Letters from F. S. Terry, F. R. Upton, and Others (E W–March 25.) 1500 w.

*11566. Recent Tests of Ferranti Meters (El–March 17.) 600 w.

*11567. The Proposed Municipal Electric Lighting Scheme for Burton-on-Trent. Ill. H. Waring (E E L–March 17.) 1000 w.

11604. The Incandescent Lamp Situation (E W–April 1.) 3800 w.

11605. The Most Economical Age of Incandescent Lamps.—Communications from B. F. Thomas, Elihu Thomson, E. P. Roberts, and W. D. Weaver (E W–April 1.) 2400 w.

11612. Lighting the Biggest Building in the World. Ill. T. C. Martin (E E N Y–March 29.) 2800 w.

11613. The Moore Regulating Lamp Socket for Alternating and Continuous Current. Ill. D. McF. Moore (E E N Y–March 29.) 500 w.

11614. Street Lighting by Private vs. Municipal Plants. Horatio A. Foster (E E N Y–March 29.) 650 w.

11615. A Convertible System of Arc Lighting and Constant Potential Power Service. Ill. S. W. Rushmore (E E N Y–March 29.) 1300 w.

*11763. The Elihu Thomson Watt Hour Meter. G. H. Baillie, W. L. Bayley, C. H. C. Woodhouse (E E L–March 24.) 1000 w.

*11773. The Electric Light in Public Buildings. Alfred H. Gibbings (E R L–March 24.) 1400 w.

11793. The Springfield, Ill., Electric Light and Steam Distribution Plant. Ill. Leslie W. Collins (E E N Y–April 5.) 2500 w.

Serials.

6709. Electric Light and Power. Ill. Arthur F. Guy (E E L–Began Sept. 19—17 parts to date—30 cts. each).

8710. Incandescence Lamp Manufacture in the United States. Leonard G. Tate (E P–Began Dec.—Ended March—3 parts—30 cts. each).

9531. Suggestions for Metering Devices. Ill. S. D. Mott (E W–Began Jan. 14—5 parts to date—15 cts. each).

10844. The Design of a Central Station for Incandescent Electric Lights. E. P. Roberts (E W–Began March 4—2 parts to date—15 cts. each).

11245. The Specification of Electric Plant and Mains for Open Competition. Thomas Tomlinson (E R L–Began March 3—2 parts to date—30 cts. each).

11836. Can a Practical All Solid Incandescent Lamp without Vacuum Be Made? F. M. F. Cazin (E A–Began April 8—1 part to date—15 cts).

GAS ENGINEERING.

11155. Every-day Pyrometry, with Discussion. E. C. Jones (A G L J–March 13) 3500 w.

*11275. Inaugural Address of Pres. W. R. Chester (J G L–March 7.) 4000 w.

11292. Our Map of New York City. Ill. (P A–March 15.) 1000 w.

11360. Notes on Naphthaline. A. H. Stecker (A G L J–March 20.) 2000 w.

11361. A Study in Calculating Heat Units. H. L. Payne (A G L J–March 20.) 700 w.

*11419. Pressure and Luminosity. W. Ivison Macadam (G W–March 11.) 2500 w.

11578. Fitzgerald's Gas Washing and Scrubbing Apparatus. Ill. (A G L J–March 27.) 1400 w.

11579. Kenevel's Process of Gas Manufacture. Ill. (A G L J–March 27.) 2000 w.

*11582. Naphthalene and Benzol in Coal Gas. Prof. Bunte (G W–March 18.) 1600 w.

*11627. Experimenting with a View to the Development of Gasholder Construction.—A Rejoinder. F. Southwell Cripps (J G L–March 21.) 2700 w.

*11628. Inaugural Address of W. Duesbury (J G L–March 21.) 3800 w.

11662. The Present and Future Competition Between Gas and Electricity. Joseph Gwynn (W E–April 1.) 1000 w.

11716. Inaugural Address of C. H. Welch (A G L J–April 3.) 3300 w.

11717. The Present State of the Art of Purification in Closed Vessels, with Discussion. S. F. Hayward (A G L J–April 3.) 5300 w.

11718. A Peculiar Gas-Electric Accident at Indianapolis, Ind. Ill. John R. Pearson (A G L J–April 3.) 600 w.

11722. Should Small Gas Companies Put in Electric Light Plants? with Discussion. H. L. Hurlburt (P A–April 1.) 6500 w.

11723. Is the Wilkinson Process Economical for Small Works? with Discussion. J. F. Seamon (P A–April 1.) 2800 w.

11724. Discrimination by Gas Companies in the Treatment of Their Consumers. G. A. Allen (P A–April 1.) 7400 w.

11792. Two Dangerous Commodities (M N–April 1.) 500 w.

*11825. An Experience with a 24-inch Gas Main. Ill. J. B. Crockett (I S F–April.) 2700 w.

HYDRAULICS.

11176. The Atlantic Highlands, N. J., Standpipe. Ill. (E R–March 11.) 1400 w.

11177. Estimation of the Loss of Water

Power in a Stream by Taking Water for a City Supply. L. M. Hastings (E R-March 11.) 1800 w.

*11217. A High-Speed Waterworks Pump. Ill. Arthur Rigg (Eng L-March 3.) 1800 w.

†11251. The Water Supply of Philadelphia, with discussion. Henry Leffmann (P E C P-Jan.) 13500 w.

†11257. Construction of the Power House of the Rochester Power Company, Adjacent to Genesee Falls, Rochester, N. Y. Ill. Robert Cartwright (T C E-Jan.) 1800 w.

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7121. Office-Help for Architects. Ill. George Hill (A A-Began Oct. 8—10 parts to date—15 cts. each).

9874. The Historic Styles and Modern Architecture. Henry Van Brunt (A Rev-Began Aug.—Ended Jan.—2 parts—45 cts. each).

10673. Architectural Terra-Cotta. Ill. Joseph Timms (B B-Began Jan.—3 parts to date—30 cts. each).

10682. The Châteaux of France. Ill. Louis H. Gibson (S-Began Feb.—3 parts to date—30 cts. each).

11170. Architecture of the Low Countries. Ill. J. van Ysendyck (A A-Began March 11—7 parts to date—15 cts. each).

11379. How to Build a Factory (T–Began March 15—4 parts to date—15 cts. each).

12207. Are Conventional Patterns Spontaneously Generated? Ill. William H. Goodyear (A R–Began April–June—1 part to date—30 cts).

12409. Color in House Decoration. A. S. Barbier (A & B–Began April 29—1 part to date—15 cts).

12414. Side Lights on Viollet-le-Duc. Massillon Rouvet (A A–Began April 29—2 parts to date—15 cts. each).

12415. Topographical and Architectural History of the City of Mexico. Ill. Arthur Howard Noll (A A–Began April 29—1 part to date—15 cts).

12568. Building Construction and Superintendence. F. E. Kidder (A & B–Began May 6—1 part to date—15 cts).

12569. The Value of Criticism. C. J. Tait (A & B–Began May 6—1 part to date—15 cts).

CIVIL ENGINEERING.

*11884. Convict Labor on Public Roads. Ill. Louis A. Pope (G R–March.) 3000 w.

*11886. Metropolitan Road-Making. Ill. (G R–March.) 1000 w.

*11887. Wheel-Tire Philosophy. Ill. (G R–March.) 2000 w.

11939. The Harvard Bridge Piers. Ill. (E R–April 8.) 800 w.

11940. Block System of Road Maintenance, Newton, Mass. (E R–April 8.) 1500 w.

†11954. Discussion on "The Controverted Questions in Road Construction," by James Owen, Edward Prince, E. W. Howe, William H. Grant, Foster Crowell, Latham Anderson, W. C. Oastler, P. Callanan, Edwin Mitchell, Samuel L. Cooper, E. E. R. Tratman, H. M. Wilson, W. S. Bacot, O. Saabye, J. F. O'Rourke, Calvin Tomkins, James Hall, E. P. North, and James Owen (T C E–Feb.) 23000 w.

12025. The Lake Brioa, or Kioto-tu Canal. Ill. (E N–April 13.) 900 w.

12026. Bridges over Navigable Waters of the United States. W. M. Black (E N–April 13.) 2300 w.

12033. Re-building a Defective Bridge Pier. Ill. (E N–April 13.) 2000 w.

12061. The Portland Cement Industry in Europe. Pierre Girou (E M J–April 15.) 1000 w.

12086. New Road Law for the State of Washington. Editorial (E R–April 15.) 600 w.

12088. The Harlem River Balanced Drawbridge. Ill. (E R–April 15.) 700 w.

12091. Sidewalk Improvement (E R–April 15.) 1000 w.

*12126. Drawbridge over the River Tiber, near Rome. Ill. (I L–April 7.) 350 w.

*12148. Shaft-Sinking with Congelation in Water-bearing Strata. A. Gobert (C G–April 7.) 1600 w.

*12151. Cantilever Combination Bridges. Editorial (Eng L–April 7.) 1800 w.

*12152. Combination Bridges in the United States. Ill. Afred D. Ottewell (Eng L–April 7.) 1000 w.

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*12302. Brick Paving (Can A–April.) 900 w.

*12312. Theory of a Parabolic Arch with Three Pivots. Ill. Maxam Ende (Eng L–April 14.) 2000 w.

*12315. Vauxhall and Lambeth Bridges (Eng L–April 14.) 2000 w.

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*12508. Annealing Paving Brick. W. Waplington (P–May.) 2000 w.

*12509. Width of Paved Roadway in City Streets. S. Whinery (P–May.) 1400 w.

*12510. The Gravel Road Movement in Parke County, Indiana. J. T. Campbell (P–May.) 3000 w.

*12512. A City Engineer's Views of Modern Street Paving. Ill. Niles Meriweather (P–May.) 1400 w.

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*12560. Roads, Good and Bad. Ill. Charles W. Darling (G R–April.) 2900 w.

*12561. Road-Law in Switzerland. Ill. Edgar R. Dawson (G R–April.) 3500 w.

*12563. Paving Bricks and How to Test Them. Ill. Gorham Dana (G R–April.) 2300 w.

†12625. The Hooghly Floating Bridge. Ill. Bradford Leslie (I E–April 1.) 4000 w.

*12640. Another Glance at Calais Harbor and Trade. Editorial (Tr–April 28.) 1000 w.

12662. Bridge Columns and Shocks of Moving Loads. Editorial and Letter (E R–May 6.) 1800 w.

Serials.

8671. Macadam and Telford Roads. Ill. Isaac B. Potter (G R–Began Nov.—3 parts to date—30 cts. each).

10780. Dredging. W. H. Wheeler (Eng L–Began Feb. 17—3 parts to date—30 cts. each).

11036. Staten Island Highways. Ill. (G R–Began Feb.—Ended March—2 parts—30 cts. each).

11182. The Nicaragua Canal (E–Began Feb. 24—5 parts to date—30 cts. each).

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11876. Electricity on Farms (M G–April 8.) 1400 w.

*11883. The "Hunting" of Parallel Alternators. James Swinburne (I L–March 31.) 1400 w.

*11912. The Alternating Current System in America. G. L. Addenbrooke (E R L–March 31.) 2000 w.

*11916. Lightning Arresters in the United States. Ill. Alexander Jay Wurts (El–March 31) 2000 w.

†11956. Discussion on "Electric Rock Blasting—The American Method," by William L. Saunders.—Spencer Miller, Samuel Whinery, James Owen, George R. Hardy, A. McC. Parker, E. P. North, and E. E. R. Tratman (T C E–Feb.) 2700 w.

*11968. Electricity as a Means of Heating (G W–April 1.) 1300 w.

11985. A Hand-Made Electro-Motor. Ill. (E N Y–April 12) 2500 w.

11987. General Electric Company's Transformers. Ill. (E R N Y–April 15) 1200 w.

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12012. On the Rotary Magnetic Field and Multiphase Alternating Current Distribution. Ludwig Gutmann (E W–April 15.) 2400 w.

12015. Electrical Progress in Germany (E W–April 15.) 1400 w

12044. Electrical Developments.—Abstract of Paper by A. E. Dolbear (B J C–April 15.) 400 w.

†12069. An Early Dynamo. Townsend Walcott (T A I E E–April.) 2500 w.

†12070. Impedance. Ill. A. E. Kennelly (T A I E E–April.) 5400 w.

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*12103. Alternating Currents and Rotary Fields. Ill. Alexander Russell (El–April 7.) 2000 w.

*12106. The Insulation Resistance of Private-House Circuits. E. Tremlett Carter (El–April 7.) 750 w.

*12107. Concentric Wiring. Sydney F. Walker (El–April 7.) 1100 w.

*12109. On the Kathode Rays in Gases at Pressure of the Atmosphere and in the Highest Vacuum. P. Lenard (El–April 7.) 1500 w.

*12110. A Hysteresis Theory of Brown's Alternating Current Motor. Criticism of J. A. Kingdom's Article. E. C. Rivingston (El–April 7.) 400 w.

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*12138. Electric Rod and Rivet Heaters. Ill. (E E L–April 7.) 1200 w.

*12139. Notes on the Influence of Electricity in Tanning Operations. Conrad K. Falkenstein (E E L–April 7.) 3500 w.

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*12176. The Jones Rotary Electric Drill. Ill. (E E N Y–April 19.) 450 w.

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*12294. Northrup's New Dry Cells. J. T. Sprague (El–April 14.) 1500 w.

*12295. Thermal Galvanometers. E. Tremlett Carter (El–April 14.) 1800 w.

*12297. The Determination of High Potential Differences. A. Heydweiller (El–April 14.) 350 w.

12362. Single Phase Alternating Current Motors. Elihu Thomson (E W–April 29.) 600 w.

12363. Theodore Puskas (E W–April 29.) 650 w.

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*12453. Household Uses of Electricity. George N. Hopkins (C E–May.) 800 w.

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*12617. Works of the National Electric Manufacturing Company. Ill. (S R E N–April.) 1400 w.

*12630. The Efficiency of Dynamos. Sydney F. Walker (C G–April 28.) 1900 w.

*12650. Terminals. J. Rennie (E E L–April 28.) 1500 w.

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11129. Some Principles that Must Be Observed in Order to Make a Good Closed Circuit Battery, and a New Portable Dry Cell Described in which These Principles Are Applied. Ill. E. F. Northrup (J F I-Began March—Ended May—3 parts—45 cts. each).

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12668. Non-Synchronous Alternating Current Motors. Dr. Behn-Eschenburg (E W-Began May 13—1 part to date—15 cts).

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12017. The Ball System of Electric Lighting. Ill. (E A-April 15.) 2000 w.

*12108. A Secondary Standard for Arc-Light-Photometry. Ill. (El-April 7.) 1850 w.

*12121. The Day Load. Editorial (E R L-April 7.) 1000 w.

*12123. Arc Lamps v. Large Incandescent Lamps for Street Lighting. Sydney F. Walker (E R L-April 7.) 1700 w.

*12124. Joint-Boxes on Under-ground Networks. Ill. (E R L-April 7.) 3000 w.

*12134. The Incandescent Illumination at the World's Fair. Ill. R. H. Pierce (W F E E-April.) 2000 w.

*12137. Underground Electric Mains in Paris. Ill. (E E L-April 7.) 1300 w.

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*12426. Some Economic Points in Connection with Electricity Supply. Gisbert Kopp (J S A-April 21.) 7000 w.

*12428. Concentric Wiring. Sam Mavor (El-April 21.) 1000 w.

*12441. Marine Electric Lighting. Ill. (E P-Jan. 1.) 63000 w.

12482. Henry Goebel. Ill. (E W-May 6.) 1350 w.

*12511. Municipal Ownership of Street Lighting Plants (P-May.) 1000 w.

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*12651. Notes on the Cost of Electric Lighting. F. B. Nicholson (E E L-April 28.) 2000 w.

We supply copies of these articles. See introductory.

12666. Sensational Charges Against the General Electric Company (E W-May 13.) 1500 w.

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6709. Electric Light and Power. Arthur F. Guy (E E L-Began Sept 9—19 parts to date—30 cts. each).

9906. Electric Light and Gas. Ed. C. De Segundo (E R L-Began Jan. 13—Ended March 31—4 parts—30 cts. each).

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12230. The Story of the Evolution of the Edison Incandescent Lamp. Ill. (E W-Began April 22—2 parts to date—15 cts. each).

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*12565. F. T. C. Linton on Oil-Gas Processes (J G L-April 25.) 3500 w.

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*12637. Gasfitting (G W-April 29.) 1300 w.

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11994. Gas Works as Central Stations for the Supply of Light, Heat, and Power. W. von Oechelhaeuser (J G L-Began April 4—Ended April 11—2 parts—30 cts. each).

HYDRAULICS.

*11900. Iron and Steel Water Tanks. Abstract of paper by William C. Coffin, Jr. (I-March 31.) 1000 w.

†11955. Discussion on "The Use of Asphaltum for Reservoir Linings," by James D. Schuyler, R. C. Gemmell, C. B. Brush, S. Whinery, J. F. Flagg, W. B. Parsons, R. L. Harris, Foster Crowell, M. Fargusson, F. Collingwood, E. P. North, and J. F. O'Rourke (T C E-April.) 7000 w.

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*12278. The Water Supply of Chicago. Editorial (E-April 14.) 1800 w.

†12307. The Use of Bone-Black in Domestic Filters, with Discussion. R. N. Clark (E S W P-Feb.) 5900 w.

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*12349. The Duty of Pumping Engines. John H. Barr (S J E-April.) 2000 w.

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INDUSTRIAL CHEMISTRY.

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*12429. The Threatened Dock and Shipping Strike.—A Review of the Situation (Tr-April 21.) 4400 w.

12434. The Nationalization of a Trade Union. Thomas Coram (B C-April 29.) 700 w.

*12437. The Strike at Hull. Editorial (I L-April 21.) 1200 w.

*12470. An Act of Trade Unionism (B A-April 21.) 1300 w.

†12502. The Ann Arbor Strike. Frank P. Sargent (N A R-May.) 2000 w.

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*12507. How a Socialist Millennium Would Work.—Eugene Richter's Pictures of the Future (R of R-May.) 14000 w.

12523. Convicts and Highways. Editorial (A S-April 29.) 600 w.

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*12634. The Regulation of Ironworkers' Wages in Staffordshire and the North of England (C G-April 28.) 1500 w.

*12639. The American View of Sympathetic Strikes. Editorial (Tr-April 28.) 1700 w.

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*11923. Discussion of paper by George A. Calvert, "The Measurement of Wake Currents" (E-March 31.) 900 w.

*11926. The Atlantic Passenger and Emigrant Trade. Editorial (E-March 31.) 850 w.

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12483. The Intra-Mural Railway at the World's Fair. Ill. (E W–May 6.) 5000 w.

*12490. Laying Out Shoes and Wedges. G. K. W. (L E–May.) 1000 w.

†12491. Studies in Track and Roadway Construction. Ill. (S R J–May) 1600 w.

†12492. Portland, Ore. Ill. (S R J–May.) 12000 w.

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12517. M. C. B. Coupler Tests. Editorial (R R–April 29.) 1800 w.

12518. Thirty-ninth Annual Report of the Chicago, Burlington and Quincy R. R. (R R–April 29.) 1500 w.

12520. How Grade Crossings May Be Abolished in Chicago. Harvey E. Park (R R–April 29) 1400 w.

12522. Regulation of Electric Railroads. Editorial (A S–April 29) 700 w.

*12529. Crossings of Great Rivers.—A Contribution to Railroad Location. Appendix. Ill. A. Zdziarski (A E R J–May.) 1800 w.

12550. Railway Improvements for the World's Columbian Exposition Traffic (E N–May 4.) 1200 w.

12553. A Natural Railway Tunnel. Ill. Emile Low (E N–May 4.) 1500 w.

12556. American, English, and Indian Railways.—Railways (E N–May 4.) 4000 w.

*12557. Notes on English Railways. E. R. Turner (J A E S–March.) 7500 w.

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12589. The Varieties of Woods Used in the Construction of Freight and Passenger Cars, at Pullman, Ill. D. Doty (R C J–May.) 1800 w.

*12596. Winby's Express Locomotive. Ill. (Eng L–April 28.) 1100 w.

*12598. Railway Accidents. Editorial (Eng L–April 28.) 1500 w.

*12600. The Pool and Hamworthy Junction Railway. Ill. (I L–April 28.) 1600 w.

†12624. Madras Railway Company (I E–April 1.) 1200 w.

*12635. Coal Production and Railway Demands in India (C G–April 28.) 1600 w.

*12643. The Great Eastern Railway and the Stratford Works. Ill. (R W–April.) 8500 w.

*12644. The Railway Commissioners of New South Wales on English Locomotives. Ill. (R W–April.) 1300 w.

*12645. The Cleaning of Tramway and Other Rails. H. Couradi (R W–April.) 3600 w.

*12646. Fines on Railways. Editorial (R R L–April 28.) 1000 w.

12648. An Old Fashioned Rate War. Editorial (R A–May 5.) 600 w.

12649. Some Practical Talk to Track Men. E. P. Hawkins (R A–May 5.) 1200 w.

12652. Why Railway Rates Are Based on Distance in Local Traffic. Jas. L. Cowles (R R–May 6.) 1800 w.

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12656. A Question of Classification. Editorial (R R–May 6.) 1000 w.

12661. Rapid Transit in Boston. Editorial (E R-May 6.) 1550 w.

12672. The Electrical Illumination of Steam Railroad Cars (E W-May 13) 700 w.

Serials.

7456. The Locomotive Boiler, Ill. Gustav Richard (A J R A-Began Oct.—Ended April—6 parts—30 cts. each).

9254. Railway Management. Horace Cope (R R-Began Dec. 31—5 parts to date—15 cts. each).

9689. Railroad Car Design. Ill. Archer Richards (R C J-Began Jan.—3 parts to date—15 cts. each).

10502. English and American Railways. Ill. William M. Acworth (E Mag-Began April—3 parts to date—30 cts. each).

11896. The Madras Electric Tramway Company (I E-Began March 4—2 parts to date—45 cts. each).

11897. Proposed Calcutta Tunnel. Ill. William Duff Bruce and J. H. Greathead (I E-Began March 4—2 parts to date—45 cts. each).

11921. Earth Slips and Subsidences. Ill. Henry E. P. Cottrell (E-Began March 31—Ended April 7—2 parts—30 cts. each).

11962. The History of the South-eastern Railway. G. A. Sekon (R P L-Began April 1—1 part to date—30 cts).

12001. Rails on the Creep. A. Ewbank (I E-Began March 11—3 parts to date—45 cts. each).

12177. The First Electric Railway in New Orleans. Ill. A. Langstaff Johnston (E E N Y-Began April 19—2 parts to date—15 cts. each).

12527. Patenall's Improved Sykes' System of Block Signals (A E R J-Began May—1 part to date—30 cts).

12614. Railway-Stations. Ill. Léon Benouville (A A-Began May 6—1 part to date—15 cts).

SANITARY ENGINEERING.

11941. Dry Closets at the Pencoyd Iron Works. Ill. (E R-April 8.) 500 w.

†11953. Discussion on "The Storm Hydro-Pneumatic System of Sewerage." F. P. Stearns, J. J. R. Croes, J. Foster Flagg, William L. Saunders, William Barclay Parsons, A. Fteley, F. W. Skinner, Rudolph Hering, and U. H. Broughton (T C E-Feb.) 9000 w.

*12096. Plumbing. John Honeyman (A L-April 7.) 5500 w.

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†12247. The Drainage of Dacca. Editorial (I E-March 18.) 700 w.

†12322. Sanitation in Burma (I E-March 25.) 1200 w.

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*12352. Sanitary Administration of New York City. Cyrus Edson (A H-May.) 3000 w.

*12353. Relation of Sanitation to Municipal Government in Wisconsin. U. O. B. Wingate (A H-May.) 3000 w.

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*12513. The Sewerage System of Memphis. George E. Waring, Jr. (P-May.) 3500 w.

*12584. The Sanitation of Country Mansions. Edward Tidman (N W-April.) 1200 w.

12663. Outlet Sewers in New York. Ill. (E R-May 6.) 800 w.

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8127. Ventilation and Heating. Ill. J. S. Billings (E R-Began Nov. 19—7 parts to date—15 cts. each).

10425. A Healthy Home. F. Vacher (S R-Began Feb. 1—6 parts to date—30 cts. each).

10942. New York Plumbing Regulations. A. H. Napier (E R-Began March 4—4 parts to date—15 cts each).

11166. Mr. Doig's Report on the Shone System at Rangoon (I E-Began Feb. 4—3 parts to date—45 cts. each).

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11870. Heating and Ventilating School Houses by the Blower System. Walter B. Snow (Met W-Began April 8—2 parts to date—15 cts. each).

12248. Dacca Municipality. Ill. Report of the Drainage Engineer. J. D. M. Beglar (I E-Began March 18—Ended March 25—2 parts—45 cts. each).

12628. Heating and Ventilation of Residences. James R. Willett (I A-Began April—1 part to date—45 cts).

STEAM ENGINEERING.

*11872. Some Experiments on the Transmission of Heat Through Tube Plates. Ill. A. J. Durston (Eng L-March 31.) 5000 w.

11875. Boiler Capacity. W. H. Wakeman (M G-April 8.) 1000 w.

*11879. Observations on the Working of an Evaporative Condenser. Ill. Michael Longridge (I L-March 31) 2000 w.

*11911. Economy of a Non-Condensing Compound Engine (E R L–March 31.) 1100 w.

*11933. Engine Fuel: An Experiment. Walter J. May (C G–March 30.) 1000 w.

*11969. McLaren's Smoke Burner. Editorial (Inv–April 1.) 600 w.

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*11977. Breakdown of Refrigerating Machinery. Manx (E G–April.) 2700 w.

*11980. The Steam Engine. Review of work by D. K. Clark (A L–March 31.) 2000 w.

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12045. Distribution of Heat and Boiler Settings. Paris, Texas (B J C–April 15.) 1800 w.

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*12100. The Darby Steam-Digger (I–April 7.) 1000 w.

*12104. Evaporative or Air Condensers for Steam Engines. Editorial (El–April 7.) 1100 w.

*12117. On the Use of Superheated Steam in Steam Engines. Bryan Donkin, Jr. (E–April 7.) 2000 w.

*12118. Harmonic Valve Diagram. Ill. W. E. Dalby (E–April 7.) 2700 w.

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12169. Latent Heat. A. D. Bartlett (A M M–April.) 700 w.

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*12296. Steam Engine Trials. P. W. Willans (El–April 14.) 750 w.

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*12346. The Design of Corliss Valve Gearing. Ill. A. H. Eldredge (S J E–April.) 1200 w.

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12395. Basis of Duty Rating of Steam Motors (Ir Age–April 27.) 1750 w.

12412. Superheated Steam. Its Value in a Steam Engine Considered (B J C–April 29.) 800 w.

*12442. Scale in Steam Boilers (M W–April 21.) 1500 w.

*12454. Piston Rod Packings. B. W. Goodsell (N C B–May.) 900 w.

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*12471. Practical Notes on the Steam Jacket. Ill. W. Fletcher (P Eng–April 21.) 2200 w.

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12592. Proper Area of Supply Pipes for Engines (P S–May.) 1600 w.

12612. The Duty of Pumping Engines (B J C–May 6.) 1600 w.

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Serials.

11102. Progress in Steam Engineering. Robert H. Thurston (E Mag–Began May—2 parts to date—30 cts each).

11138. Notes on the Steam Injector. Ill. Strickland L. Kneass (E M–Began March—2 parts to date—30 cts. each).

11180. The Expansion of Water by Heat. G. W. Buckwell (S L–Began March—Ended April—2 parts—30 cts. each).

11720. Steam Boilers (T–Began April 1—3 parts to date—15 cts each).

12377. Steam Shovels and Steam Shovel Work. Ill. E. N. Herrmann (E N–Began April 27—2 parts to date—15 cts. each).

TELEPHONY AND TELEGRAPHY.

11878. Progress in Fire Alarm Telegraphy. J. W. Stover (F W–April 8.) 3000 w.

*11909. The Telephone in Vienna. J. Hopkinson (E R L–March 31.) 1200 w.

†11952. Imperial Telegraph System — Cabling to India and Australia. J. Henniker Heaton (C R–April.) 4800 w.

*11967. Telephony in England. Editorial (E L–March 31.) 1300 w.

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*11919. The Need for a Technical Index (J G L-March 28.) 2000 w.

*11924. The American Inventor. Editorial (E-March 31.) 3100 w.

11938. New York Fire Protection and Street Cleaning. Editorial (E R-April 8.) 700 w.

*11970. The Reign of the Horse. H. N. Hutchinson (Inv-April 1.) 2400 w.

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†12145. The Peruvian Corporation and Rubber. J. Orton Kerbey (I R W-April 15.)1600 w.

†12146. Rubber-Tree Culture in Mexico. The Mexican Minister (I R W-April 15.) 5000 w.

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†12191. What Hinders Emigration to Australasia? M. (W R-April.) 5200 w.

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12225. A Plan for Stimulating Southern Immigration. Editorial (M R-April 21.) 1200 w.

12234. Aerial Navigation. Editorial (E R-April 22.) 1200 w.

12237. Hot-Water Heating of a Suburban Residence. Ill. (E R-April 22.) 500 w.

12246. The Ethics of Engineering. John W. Ellis, William E. M'Clintock, and Albert F. Noyes (R G-April 21.) 2200 w.

*12253. New St. Louis. Ill. James Cox (L Mag-May.) 5500 w.

12285. Some Notes on Lighthouse Apparatus. J. Kenward (Sc-April 21.) 2300 w.

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†12503. The Hawaiian Situation. Theophilus Harris Davies (N A R-May.) 2000 w.

*12605. County Councils and Technical Education. Editorial (E-April 28.) 2500 w.

*12636. Some Problems of Municipal Engineering. C. D. Marx (I S F-May.) 6000 w.

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12682. Social and Industrial Conditions of Arkansas. W. M. Finback (S S-May.) 1500 w.

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9745. American Industries and British Commerce (E-Began Jan. 6—13 parts to date—30 cts. each).

10535. Notes from the Engineering Schools (E N-Began Feb. 16—6 parts to date—15 cts. each).

11346. Historical Notes upon Early American Engineers and Their Work. Hale G. Robinson (Eng-Began March 18—4 parts to date—15 cts. each).

11678. Hot-Air Heating. Ill. (Met W-Began April 1—Ended April 8—2 parts—15 cts. each).

12382. The Ideal Engineering School (E N-Began April 27—2 parts to date—15 cts. each).

12477. Argentine (Eng L-Began April 1—2 1 part to date—30 cts).

12540. Early Engineering Reminiscences. George Escol Sellers (A M-Began May 4—1 part to date—15 cts).

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NEW BOOKS OF THE MONTH.

[For the convenience of readers any American books will be supplied at publishers' prices by The Engineering Magazine Co. Foreign books, 25 per cent. extra.]

Alexander, P.=Treatise on Thermodynamics. New York: Longmans, Green & Co. [8vo, cloth, 215 p., $1.50.]

Barr, W. M.=Pumping Machinery. A practical hand-book relating to the construction and management of steam power pumping machines. Philadelphia: Lippincott. [8vo, cloth, 447 p., $5.]

Benjamin, Park.=The Voltaic Cell. New York: Wiley. [8vo, cloth, 466 p., $5.]

Billings, J. S.=Ventilation and Heating. New York: The Engineering Record. [8vo, cloth, 500 p., $6.]

Bodley, C. E.=Pocket Reference Book for Tinsmiths and Sheet Metal Workers. Chicago: American Artisan Press. [63 p., paper.]

Brainard, F. R.=Knots, Splices, Hitches, Bends, and Lashings. New York: Practical Publishing Co. [16mo, 76 p., cloth, $1.]

Buckley, Robert Burton.=Irrigation Works in India and Egypt. A reference book with 100 folding plates and maps. New York: Spon & Chamberlain. [8vo, cloth, 340 p., $25.]

Catalogue of Berlin Iron Bridge Company. Complete and clear illustrations of the buildings, bridges, and general iron work of the company. Of special interest to manufacturers and engineers. East Berlin, Conn.: The Berlin Iron Bridge Co. [317 p., paper. Free on application.]

Catalogue of Niagara Stamping and Tool Company. Illustrations of Tools and Machines for Working Sheet Metal. Buffalo: Niagara Stamping and Tool Co. [104 p., Free on application.]

Chapman Valve Manufacturing Company.=Catalogue of Gate Valves and Fire Hydrants, with an Engineering Appendix. A book of great value to engineers, machinists, and all having to do with the construction or maintenance of work of all kinds. It also contains valuable articles on steam, electricity, and refrigeration. Hartford: Plimpton Press. [8vo, cloth, 146 p. Free to patrons on application.]

Cronkhite, Adelbert.=Gunnery for Non-commissioned Officers. New York: Wiley. [18mo, morocco, 450 p., $2.]

Garnsey, G. O.=The American Glossary of Architectural Terms. Being a concise and comprehensive compilation of all terms used in the practice of architecture and the building arts, with selected and original drawings. Chicago: Koelling & Klappenbach. [4to, cloth, $2.]

Goodhue, W. F.=Municipal Improvements. New York: Wiley. [12mo, cloth, 137 p., $1.50.]

Gotch, J. Alfred, and Brown, W. Talbot.=Architecture of the Renaissance in England. Illustrated by a series of views and details from buildings erected between the years 1560–1630, with historical and critical text. Boston: Ticknor. [Folio, 6 parts, paper, $8 per part.]

Goubert Manufacturing Co. (The).=Dry Steam the Foundation of Economy, with Description of The Stratton Separator. An illustrated catalogue with testimonials. New York: [8vo, paper, 36 p. Free on application.]

Grimshaw, Robert.=Engine-room Chat. New York: Practical Publishing Co. [12mo, cloth, 152 p., $1.]

Grimshaw, Robert.=Fifty Years Hence; or What May Be in 1943. A prophecy supposed to be based on scientific deductions by an improved graphical method. New York: Practical Publishing Co. [16mo, cloth, 92 p., $1.]

Haupt, Herman.=Street-Railway Motors. With descriptions and cost of plants and operation of the various systems in use or proposed for motor-power on street-railways. Philadelphia: H. Carey Baird & Co. [12mo, cloth, 213 p., $1.75.]

Hicks, I. P.=Hicks' Builders' Guide; Comprising an easy practical system of estimating material and labor for carpenters, contractors, and builders: a guide to those engaged in the various branches of the building trades. New York: Williams. [12mo, cloth, 162 p., $1.]

Hill, Robert Thomas.=On the Occurrence of Artesian and Other Underground Waters in Texas, Eastern New Mexico, and Indian Territory, West of the Ninety-Seventh Meridian. Washington: Government Printing Office. [8vo, paper, 166 p., with Maps, $1.50.]

Hofman, H. O.=The Metallurgy of Lead and the Desilverization of Base Bullion. New York: The Scientific Pub. Co. [8vo, cloth, 415 p., $6.]

Hopkins, W. J.=Telephone Lines and Their Properties. New York: Longmans, Green & Co. [12mo, cloth, 272 p., $1.50.]

Houston, Edwin J.=Electrical Measurements and Other Advanced Primers of Electricity. New York: W. J. Johnston Co. [8vo, cloth, 479 p., $2.]

Jarchow, H. N.=Forest Planting. A treatise on the care of timber lands and the restoration of denuded wood-lands on plains and mountains. New York: Orange Judd Co. [12mo, cloth, 250 p., $1.50.]

Kapp, Gisbert.=Alternating Currents of Electricity. Their generation, measurement, distribution, and application. New York: W. J. Johnston Co. [8vo, cloth, 166 p., $1.]

Keenan, W. J. and Riley, J.=The Transmitted Word. Boston: Dorchester Press Co. [12mo, cloth, 116 p., 75 cts.]

Leon, Nestor Ponce de.=Diccionario Technológico, Inglés-Español y Español-Inglés. De los terminos y frases usados en las ciencias aplicadas, artes, industriales, bellas artes, mécanica, maquinaria, minas, metalurgia, agricultura, comercio, navegacion, manufacturas, arquitectura, ingenieria, civil y militar, marina, arte militar, ferro-carriles, telegrafos, etc. New York: N. Ponce de Leon. [8vo, half leather, 873 p., $8.50.]

ARCHITECTURE.

*12683. Sculptors of the World's Fair. Ill. J. H. Gest (E Mag-July.) 4000 w.

*12684. Mechanical Aids to Building. Ill. George Hill (E Mag-July.) 3000 w.

*12715. Painting Brickwork. Arthur Seymour Jennings (Pl D-May 1.) 1000 w.

*12716. Suggestions for Designs from Foliage—The Palm. Ill. H. Leslie Ramsey (Pl D-May 1.) 1600 w.

*12717. A Chat about Ceilings. W. N. B. (Pl D-May 1.) 1700 w.

12756. Sanitary School Buildings. Walter S. Pardee (A & B-May 13.) 4300 w.

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*12785. Water-Tight Construction of Window Frames. Ill. I. P. Hicks (N B-May.) 1100 w.

12789. Architectural Competition for the Washington State Capitol. Editorial (E R-May 13) 1200 w.

*12832. Hygiene in its Application to the Arrangement of Buildings. P. Gordon Smith (A L-May 5.) 8800 w.

*12833. Dunblane Cathedral (A L-May 5.) 1700 w.

†12878. On the Construction of Theaters from an Optical Point of View. Ill. René De Saussure (T A E V-March.) 8300 w.

*12974. The Imperial Institute. Editorial and Description (A L-May 12.) 4000 w.

*12975. Building in Australia (A L-May 12.) 1100 w.

*12976. Oxford, Rouen, and Nuremberg (A L-May 12.) 1500 w.

*13031. Construction of Hard Wood Doors (Can A-May.) 1000 w.

13099. Iron and Steel in Building Construction. F. E. Kidder (A & B-May 27.) 3500 w.

13102. Mortar. Nomag (A & B-May 27.) 900 w.

13105. Munich (A A-May 27.) 2100 w.

*13115. On the Early Temple and Pyramid Builders. J. Norman Lockyer (N-May 18.) 5000 w.

†13146 New Convent Building, Bangalore. Ill. (I E-April 29) 700 w.

*13189. Early Christian Mosaics (A L-May 19.) 2500 w.

*13190. How to Use Vitruvius. G. Baldwin Brown (A L-May 19.) 1200 w.

*13191. The Stone Buildings of the Cotswolds. Guy Dawber (A L-May 19.) 5500 w.

*13192. St. Peter's Church, St. Albans. F. W. Kinneir Tarte (A L-May 19.) 2400 w.

†13200. Stained Glass as an Architectural Adjunct. W. A. Hazel (I A-May.) 2600 w.

†13201. The Development of Tile Fireproof Construction (Abstract). R. Gustavino (I A-May.) 2000 w.

13210. The Ups and Downs of the Profession. Max Drach (S A-June.) 2500 w.

13214. Erection of Scaffolds (C & B-June.) 800 w.

13215. Competition in Store Fronts. Ill. (C & B-June.) 900 w.

13243. Building Ordinances of the City of Chicago (E N-June 1.) 1600 w.

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*13376. The Valuation of Property. G. V. Blackburne (A L-May 26) 3500 w.

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*13425. The Superintendence of Buildings (N B-June.) 1200 w.

13428. Improved Building Construction. Ill. (M & B-May.) 1700 w.

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9508. Ideality in Architecture. J. C. Worthington (J A-Began Dec.—2 parts to date—30 cts. each).

12409. Color in House Decoration. A. S. Barbier (A & B-Began April 29—Ended May 13—2 parts—15 cts. each).

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12568. Building Construction and Superintendence. Ill. F. E. Kidder (A & B-Began May 6—3 parts to date—15 cts. each).

12569. The Value of Criticism. C. J. Tait (A & B-Began May 6—Ended May 20—2 parts—15 cts. each).

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13093. Laying Steel Roofing. Ill. L. S. Bonbrake (Met W-Began May 27—1 part to date—15 cts).

13358. Modern Asylums for the Insane. George H. Bibby and Ernest A. E. Woodrow (A A-Began June 3—1 part to date—15 cts).

We supply copies of these articles. See introductory.

13107. Terra-Cotta and Faience as Materials for Architectural and Decorative Application (B B-Began April—1 part to date—30 cts).

CIVIL ENGINEERING.

†12705. Colombo Harbor. Editorial (I E-April 8.) 1200 w.

†12706. Colombo Harbor. Ill. John Coode (I E-April 8.) 4500 w.

†12708. The Diary of a Recalcitrant Well. Ill. F. J. E. Spring (I E-April 8.) 1200 w.

†12733. A Note on Pin-Plates, with Discussion. Ill. Thomas H. Johnson (E S W P-March.) 3800 w.

†12740. The Reconstruction of Ninth Street Bridge, Pittsburg, Pa., with Discussion. Ill. Gustave Kaufman (E S W P-Vol. VIII.) 10000 w.

12746. The Stability of Foundations under Varying Angles of Load-Application. Ill. James L. Greenleaf (E N-May 11.) 800 w.

†12871. Public Highways and Roads in Virginia.—Their Construction and Maintenance. Oscar Saabye (T A E V-March.) 3300 w.

†12874. Description of Methods Used in the Construction of the Iron Coal Pier, Norfolk and Western Railroad Company, at Lambert's Point, Norfolk, Va. W. W. Coe (T A E V-March.) 1500 w.

12937. Common Sense in the Improvement of Country Roads (E N-May 18.) 1750 w.

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*12992. Natural and Artificial Cements in Canada. H. P. Brumell (C T J-May 13.) 600 w.

12996. The Evolution of Bridge Trusses. Ill. Mansfield Merriman (R A-May 19.) 4200 w.

*13004. Theory and Practice. (Extract) Benjamin Baker (El-May 12.) 1000 w.

*13010. The Richmond Lock and Tidal Weir, with Discussion. Ill. J. B. Hilditch (J S A-May 12.) 8500 w.

*13028. Bridge Construction in Austria. Ill. (I L-May 12.) 200 w.

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*13269. Our Pavements. John Donnelly (J A E S-April.) 2200 w.

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*12820. Electrical Nomenclature. Editorial (E R L-May 5.) 1500 w.

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*12824. Fault Finding in Conductors. (Extract) M. Kallmann (E R L-May 5.) 900 w.

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*12844. Dynamos for Lecture Purposes. Ill. (E L-May 5.) 700 w.

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*13391. The Electric Heater. T. Ahearn (E I-June.) 1200 w.

*13392. Electric Heating. S. B. Jenkins (E I-June.) 2500 w.

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*13281. Inclined Retorts at the Coventry Gas Works. George Winstanley (J G L–May 23.) 2800 w.

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*13283. The Application of Machinery for Working Horizontal Retorts. C. C. Carpenter (J G L–May 23.) 3500 w.

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*13285. Discussion on the Papers by Prof. Lewes and Mr. Glasgow on "Carburetted Water Gas" (J G L–May 23.) 9500 w.

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*13335. Gas Engine Valve Setting. Ill. W. H. Cornell and B. V. Swenson (Tech–No. 7.) 1000 w.

*13416. Discussion of Paper by J. J. Hood and J. Gordon Salamon on the Application of Weldon Mud to Gas Purification (J G L–May 30.) 5500 w.

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Serials.

11993. Oxide of Iron: A Monograph. John T. Sheard (J G L–Began April 4—Ended May 2—5 parts—30 cts. each).

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*13369. Water Supply from Deep Wells. Editorial (E-May 26.) 900 w.

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Serials.

*12685. Development of the Modern Steam Pumping Engine. Ill. William W. Barr (E Mag-Began July—1 part to date—30 cts).

13343. The River Nile. Ill. H. Droop Richmond (J A C S-Began Jan.—1 part to date—45 cts).

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*13030. Technical Chemistry at Burlington House (I L-May 12.) 900 w.

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*12687. The Weak Points of Trade Unionism. Lawrence Irwell (E Mag-July.) 3000 w.

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13079. The Quaker City and Northeastern Elevated Railways, Philadelphia, Pa. Ill. (E N-May 25.) 750 w.

13080. Four-Track Steel Viaduct in New York City, New York Central and Hudson River R. R. Ill. (E N-May 25.) 2500 w.

13085. The Rapid Transit Problem in New York. Editorial (E N-May 25.) 900 w.

13086. The Railway Accident at Lafayette, Ind. (E N-May 25.) 2500 w.

13096. The Terminal Reorganization (M R-May 26.) 1550 w.

13107. The Johnson Signals in the Fourth Avenue Tunnel, New York. Ill. Arthur H. Johnson (R G-May 26.) 2000 w.

13109. Wattson and Stewart's Automatic Block Signal System for Tunnels (R G-May 26.) 800 w.

13110. World's Fair Travel. Editorial (R G-May 26.) 2100 w.

13111. A Suggested Economy in Freight Car Repairs. Editorial (R G-May 26.) 1000 w.

13121. Origin and Administration of the Interstate Commerce Law. James A. Logan (R R-May 27.) 3300 w.

13124. New York and Chicago Car Service (R A-May 26.) 800 w.

13125. A Night Ride Down the Andes. J. Orton Kerbey (R A-May 26.) 2500 w.

13126. A Standard Freight Truck.—The Possibility of Adopting One and the Difficulties in the Way (R A-May 26.) 2000 w.

*13132. The Boyer Railway Speed Recorder. Ill. (Eng L-May 19.) 800 w.

*13143. Light Railways at Mines. Walter J. May (Inv-May 20.) 800 w.

*13156. Tests of Railway Iron in France. M. Mussy (C G-May 19.) 2200 w.

*13166. Effect of Earthquakes on Northwestern Railway, India. Ill. (E-May 19.) 600 w.

13213. Bellefontaine Railway, St. Louis. Ill. (S R G-May 27.) 1700 w.

*13219. The Empire State Express Locomotive.—No. 999. Ill. (N C B-June.) 2000 w.

*13220. Inside Finish of Passenger Cars. Robert M'Keon (N C B-June.) 1200 w.

*13221. Boiler Explosions on the Reading (N C B-June.) 2700 w.

*13222. The Austrian Royal Train. Ill. (N C B-June.) 700 w.

13234. The Broad Street Station Train Shed; Pennsylvania R. R., Philadelphia. Ill. (E N-June 1.) 2000 w.

13241. A Compromise System of Live Loads for Designing Railway Bridges (E N-June 1.) 900 w.

*13245. The Locomotive "James Toleman." Ill. (L E-June.) 700 w.

*13246. An Exciting Night on a Confederate Soldier Train. C. S. Anderson (L E-June.) 1700 w.

*13247. Making Locomotive Engineers—Two Processes. J. J. Clair (L E-June.) 2500 w.

13249. An Ancient Traveler—The "John Bull." Ill. William Morris Hayes (I Age-June.) 1000 w.

*13274. Electric Accumulator Traction at Birmingham. Ill. (R W-May.) 3000 w.

*13275. Some Features of the Swindon Locomotive Works. Ill. (R W-May.) 4000 w.

*13276. The London Tramway Company's Cable Road (R W-May.) 2300 w.

13277. High Speed Electric Traction—Letters from Frank B. Lea and Albion T. Snell (R G-June 2.) 1800 w.

13278. The 20-Hour Trains Between New York and Chicago. (R G-June 2.) 2500 w.

13279. The Lafayette Accident. Editorial (R G-June 2.) 2600 w.

*13289. Ordinary Types of Belgium State Railway Locomotives. Ill. G. Brack (A E R J-June.) 4800 w.

*13314 Types of Locomotive Used on the Japanese Railways. Ill. (I L-May 26.) 1000 w.

*13338. A Peculiar Instance of Grade Reduction. F. K. Vial (Tech-No. 7.) 1800 w.

*13341. Equivalent Circular Curves for Railroad Turnouts. R. C. Vial (Tech-No. 7.) 1000 w.

*13347. Cheap Traction or Defective Telephones (E R L-May 26.) 1500 w.

†13371. The Murren Cable Incline and Electric Mountain Railway. Ill. (S R J-June.) 1900 w.

†13372. San Francisco, Cal.—The Birthplace of the Cable Railway. Ill. C. B. F. (S R J-June.) 2200 w.

†13373. The Wheless Electric Railway Company's Conduit and Aerial Trolley System. Ill. A. L. Register (S R J-June.) 2000 w.

13384. Discrimination by Railways. Martin C. Knapp (R R-June 3.) 2200 w.

13385. The Lighting of Railway Trains. Ill. Harry Pollitt and L. R. Manchester (R R-June 3.) 2800 w.

13387. Turning Railway Switches by Electricity. Ill. (R R-June 3.) 1200 w.

13388. The Personal Element in Railway Operation (R R-June 3.) 600 w.

We supply copies of these articles. See introductory.

13389. Tons and Revenue not Synonymous Terms (R R-June 3.) 1400 w.

13390. The Extent to which Railroad Companies Must Provide for Their Employés' Safety (R R-June 3.) 1800 w.

13400. Tests of Street Railway Return Circuits. Lucius T. Gibbs (E W-June 10.) 1000 w.

13432. Application of Electric Propulsion by Accumulators to the Tramways of Paris (Sc A-June 10.) 1000 w.

13450. Harvey Steel Cars. Ill. (E N-June 8.) 700 w.

13452. The Record of Janney Coupler Breakages. Ill. (E N-June 8.) 800 w.

13457. Amendments to the Interchange Rules (E N-June 8.) 1300 w.

13459. Some Automatic Brake Slack Adjusters. Ill. (E N-June 8.) 900 w.

13475. The Coupler Tests of the Western Railway Club. Ill. (R G-June 9.) 2500 w.

13476. Standard Trucks and Frames for Freight Cars. Editorial (R G-June 9.) 1800 w.

Serials.

9254. Railway Management. Horace Cope. (R R-Began Dec. 31—6 parts to date—15 cts. each).

11962. The History of the South Eastern Railway. G. A. Sekon (R P L-Began April—2 parts to date—30 cts. each).

11974. Railroad Management, Past, Present, and Prospective Quintin McNab (R R-Began April 8—2 parts to date—15 cts. each).

12001. Rails on the Creep. Ill. A. Ewbank (I E-Began March 11—7 parts to date—45 cts. each).

12527. Patenall's Improved Sykes System of Block Signals. Ill. (A E R J-Began May—2 parts to date—30 cts. each).

12614. Railway Stations. Ill. Leon Benonville (A A-Began May 6—2 parts to date—15 cts. each).

12984. Some Notes on the Design of Series Motors for Traction. Ill. J. Douglas Dallas (E R L-Began May 12—Ended May 26—2 parts—30 cts. each).

SANITARY ENGINEERING.

*12713. Ideal Drainage. Editorial (Pl D-May 1.) 1100 w.

12749. The London "Lancet" on Chicago's Water Supply and Sewage Disposal Systems. Ill. (E N-May 11.) 3200 w.

12792. The Lake Union Sewer Tunnel, Seattle, Wash. Ill. (E R-May 13.) 1200 w.

*12811. Margate-Sewerage Works.—Hydraulic Sewage Pumps. Ill. (Eng L-May 5.) 2000 w.

†12877. Heating and Ventilation. R. P. C. Sanderson (T A E V-March.) 3500 w.

†12880. Flood Waves in Sewers.—Continued Discussion. Arthur N. Talbot and Alva J. Grover (T C E-March.) 1700 w.

12964. The Sewerage of Charlottetown, P. E. I. George E. Waring, Jr. (A A-May 20.) 2800 w.

13008. Recent Municipal Work in Omaha. Ill. (E R-May 20.) 1600 w.

13081. The Old Metropolitan Sanitary District of New York, 1866 to 1870 (E N-May 25.) 450 w.

13106. Ventilation (A A-May 27.) 1600 w.

13116. Method of Making a Sanitary Investigation of a River (Sc-May 26.) 1800 w.

13122. The Ventilation and Heating of Schools. Fred P. Smith (A Ar-May 27.) 2500 w.

13136. Sewage Pumping at Leicester, England (E R-May 27.) 2000 w.

*13196. Cleaning Asphalt Pavements.—A Short Chapter on Tools and Methods. (G R-May.) 2000 w.

13212. The School-Room and the Health of the Children (S A-June.) 600 w.

13239. A Day on the Chicago Drainage Canal. Ill. (E N-June 1.) 3200 w.

13244. The Lasting Character of Soil Pollution (E N-June 1.) 1500 w.

13296. The Heating and Ventilation of Halls and Theaters by the Blower System. Ill. Walter B. Snow (Met W-June 3.) 2500 w.

*13340. Heating and Ventilation of Residences. James R. Willett (Tech-No. 7.) 5500 w.

13350. Some Foreign Methods of Air Moistening and Ventilation. Ill. (E R-June 3.) 800 w.

13379. Disinfectants and Disinfection. David Bevan (Sc-June 2.) 1500 w.

13486. The Collection and Disposal of Garbage. Editorial (M R-June 9.) 700 w.

Serials.

5358. Sewage Purification in America. Ill. (E N-Began July 14, 1892—26 parts to date—15 cts. each).

10425. A Healthy Home. Francis Vacher (S R-Began Feb. 1—8 parts to date—30 cts. each).

12628. Heating and Ventilation of Residences. Ill. James R. Willett (I A-Began April—2 parts to date—45 cts. each).

12780. The Heating Contractor. Leicester Allen (D E-Began May 13—1 part to date—15 cts).

13100. Plumbing. John Honeyman (A & B-Began May 27-Ended June 10—2 parts—15 cts. each).

13290. Sewage Disposal. J. Foster Flagg (P-Began June—1 part to date—30 cts).

STEAM ENGINEERING.

*12690. Steam Locomotion on Common Roads. William Fletcher (E Mag-July.) 3000 w.

12693. Boiler Furnaces for Burning Straw. George G. Smith (S E-April 29.) 600 w.

*12698. Note on the Reactive Influence of Steam. W. J. Millar (S L-May.) 1700 w.

12700. Steam vs. Water Power. Samuel Webber (Ir Age–May 11.) 1150 w.

*12711. Who Was Inventor of the Triple-Expansion Engine? (E G–May.) 800 w.

†12735. On Smoke, with Discussion. William Metcalf (E S W P–Vol. VIII.) 1900 w.

†12743. Report of the Committee on Smoke Prevention," with Discussion (E S W P–Vol VIII.) 9300 w.

12748. Tests of Non-conducting Coverings for Steam Pipes. Ill. R. C. Carpenter (E N–May 11.) 2200 w.

†12775. The Variation in Economy of the Steam Engine Due to Variation in Load. R. C. Carpenter (T A I E E–May.) 4500 w.

12776. Water Columns. W. H. Wakeman (M G–May 13.) 850 w.

12779. How to Fire a Boiler.—The Best Practice for Economy and Large Duty.—Paris, Texas (B J C–May 13.) 1600 w.

12784. Progress in Steam Engineering. Robert H. Thurston (Eng–May 13.) 2600 w.

*12813. Coppers for Fire Boxes. Editorial (Eng L–May 5.) 2500 w.

*12827. Steam Pipes. Messrs. Geipel and Kilgour (El–May 5.) 500 w.

†12869. Steam Boiler Explosions. C. G. Cushman (T A E V–March.) 1200 w.

12896. The Allis Quadruple Expansion Engine at the World's Fair. Ill. (Ir Age–May 18.) 2200 w.

12908. The Use and Abuse of Stationary Steam Boilers. Millard F. Burgess (S M–May 15.) 1100 w.

12911. A Condenser Pattern. Ill. Joseph Horner (A M–May 18.) 1400 w.

12968. Trouble with a Blow-off Pipe. Ill. (B J C–May 20.) 600 w.

12969. About Economizers (B J C–May 20.) 700 w.

12970. About Lubrication (B J C–May 20.) 1200 w.

12971. Piston-Rod Packing (B J C–May 20.) 1000 w.

13045. The Slide Valve. Ill. William B. Austin (S E–May 13.) 2000 w.

†13060. The Baldwin Compound Locomotive. Ill. S. M. Vauclain (P E C P–April.) 3000 w.

*13064. A Speaking Whistle (S R E N–May.) 1000 w.

13068. The Genesis and Exodus of Steam. George H. Babcock (Sc A S–May 27.) 5000 w.

13077. An Important Consideration in the Design of Boilers with Curved Back Heads. Ill. (Ir Age–May 25.) 1000 w.

13112. The Testing of Boilers. Abstract of paper by J. T. Milton (Eng–May 27.) 1400 w.

13161. A Simple Steam Trap. Ill. (B J C–May 27.) 750 w.

13162. Boiler Settings and Rapid Combustion. Lawrence Nordland (B J C–May 27.) 1500 w.

13163. Doubling Belts.—An Engineer's Argument in Favor of the Practice (B J C–May 27.) 800 w.

*13167. Boilers in the Navy. Ill. (E–May 19.) 14 0 w.

*13168. Steam Capstans and Windlasses. Ill. (E–May 19.) 1000 w.

*13174. The Cyclogram. Ill. (E–May 19.) 600 w.

*13183. Division of Steam Used Between Ends of Cylinder, in Hirn's Analysis. R. S. Hale (S J E–May.) 900 w.

*13185. Economy of a Non-Condensing Compound Engine. Ill. R. C. Carpenter (S J E–May.) 4800 w.

*13260. Grooving in Steam Boilers. Ill. Edward G. Hiller (P Eng–May 26.) 2000 w.

13297. Simple vs. Compound Locomotives, with Editorial. R. H. Thurston (R A–June 2.) 4000 w.

*13302. The Ejector Condenser. Ill. (Eng L–May 26.) 4500 w.

13352. Steam Plants on Upper Floors. Charles H. Fitch (S E–May 27.) 650 w.

13361. Taking Exhaust Steam from Engine Receivers. Ill. (B J C–June 3.) 1800 w.

13362. Scale in Boilers.—What It Shows About the Circulation of the Water. Paris, Texas (B J C–June 3.) 900 w.

13422. Errors in Indicator Reducing Gear. Ill. M. E. (A M–June 8.) 1500 w.

13462. Smoke Prevention. Olin A. Landreth (E N–June 8.) 3000 w.

†13467. Measurement of Steam by the Flow through an Orifice. Ill. E. F. Miller and C. A. Read (T Q–Dec.) 900 w.

13478. The Keene Explosion (B J C–June 10.) 500 w.

13479. Steam Ports and Pipes.—Their Proper Size for Compound Engines (B J C–June 10.) 1500 w.

Serials.

9817. The Injector. I. B. Rich (S M–Began Jan. 15—3 parts to date—15 cts. each).

11138. Notes on the Steam Injector. Ill. Strickland L. Kneass (E M–Began March—3 parts to date—30 cts. each).

11720. Steam Boilers. James F. Hobart (T–Began April 1—4 parts to date—15 cts. each).

12377. Steam Shovel Work. Ill. E. A. Hermann (E N–Began April 27—5 parts to date—15 cts. each).

13033. Practical Hints to Boilermakers and Ternplaters (M W–Began May 12—1 part to date—30 cts).

TELEPHONY AND TELEGRAPHY.

*12821. Telegraphic Communication in the West Indies. R. B. Anderson (E R L–May 5.) 4000 w.

12854. Telephone Progress in St. Louis (E R N Y–May 20.) 900 w.

12920. Modern Equipment of Telephone

Stations. Ill. W. H. Hyde (W E-May 20.) 1600 w.

*12980. Rental v. Telephonemeter (E R L-May 12.) 1200 w.

13042. Telephone Charges.—Sensation vs Facts (E R N Y-May 27.) 850 w.

†13074. A Cable to Port Blair (I E-April 22.) 2000 w.

†13465. Lightning and Strong Current Arresters as Used for the Telephone. Ill. I. H. Farnham (T Q-Dec.) 4000 w.

Serials.

12861. Reminiscences of Early Telephone Days. F. E. Kinsman (E E N Y-Began May 17—Ended May 24—2 parts—15 cts. each).

MISCELLANEOUS.

*12691. The World's Fair International Engineering Congress. J. K. Freitag (E Mag-July.) 3000 w.

12702. To Workingmen. Is Labor a Curse? R. G. Horr (B I S-May 10.) 2000 w.

12732. The Southern Immigration Question. D. Allen Willey (M R-May 12.) 1200 w.

12768. The Reform Club Tariff Bill, with Editorial (O P D R-May 15.) 1500 w.

12782. Restoring the Columns in the Piazetta, Venice (A A-May 13.) 1800 w.

*12799. The Industrial Development of India. Editorial (E-May 5.) 1700 w.

*12800. Phillip's Flying Machine. Ill. (E-May 5.)

*12804. What is Technical Education? Editorial (I L-May 5.) 1300 w.

*12808. Liverpool Cold Storage and Ice Company, Limited. Ill (Eng L-May 5.) 1000 w.

†12866. Sketch of Sir Archibald Geikie. Ill. (P S M-June.) 4000 w.

*12883. The Canal System of Canada. Allan Ross Davis (Ch-June.) 9000 w.

12899. Evolution of the Bicycle. Ill. (Ir Age-May 18.) 4000 w.

12909. Engineering Progress.—Address of Alfred E. Hunt (S M-May 15.) 1600 w.

12917. Erecting a Heating Apparatus. Helios (Met W-May 20.) 1600 w.

†12922. Madras Engineering College (I E-April 15.) 1400 w.

12930. Southern Advantages as Viewed by a Massachusetts Cotton Manufacturer. W. C. Lovering (M R-May 19.) 1000 w.

12958. The Centralization of Industries. Editorial (A S-May 20.) 500 w.

*12993. A Sidelight on a Great Canal Scheme. Editorial (Tr-May 12.) 950 w.

*13022. The Spectroscope of the Alleghany Observatory. Ill. (E-May 12.) 4000 w.

*13026. The James Forrest Lectures. Editorial (E-May 12.) 2100 w.

*13027. The Royal Society Soiree (E-May 12.) 3000 w.

†13035. Grave Obstacles to Hawaiian Annexation. Thomas M. Cooley (F-June.) 8300 w.

†13036. China's View of Chinese Exclusion. Gilbert Reid (F-June.) 3600 w.

13071. The Manufacture of Bicycles. Ill. (Sc A S-May 27.) 4500 w.

13151. Technical Education in Europe. Ill. Frank C. Perkins (E W-June 3.) 1200 w.

*13164. The Columbian Exposition. J. D. (E-May 19.) 9000 w.

*13184. A Suggestion in Aeronautics. A. P. Zanm (S J E-May.) 1400 w.

13204. The Discoverers of America. Gardiner G. Hubbard (Sc A S-June 3.) 7500 w.

13225. After the Timber is Cut. Land Owner (M R-June 2.) 1500 w.

†13230. A Look Ahead. Andrew Carnegie (N A R-June.) 12400 w.

13232. The Engineering Department of McGill University. Ill. (E N-June 1.) 2000 w.

13238. The Status of Engineers and a Proposed Plan for Improving It. Ernest McCullough (E N-June 1.) 1300 w.

*13252. The Rise and Decline of the Hawaiian Monarchy. Ill. Herbert H. Gowen (Cos-June.) 4800 w.

*13331. Brickmaking on South American Railways. P. Mogensen (Tech-No. 7.) 1600 w.

†13342. The Determination of the Relative Sensitiveness of Explosive Substances Through "Explosions by Influence." Charles E. Munroe (J A C S-Jan.) 1800 w.

*13355. Russian Industrial Art. E. A. Delmar-Morgan (B A-May 26.) 2800 w.

*13365. The Opening of the Columbian Exposition. J. D. (E-May 26.) 5500 w.

*13366. The Extension of University College. Ill. (E-May 26.) 7000 w.

*13370. Charges for Power at Jackson Park (E-May 26.) 2000 w.

*13381. The New Port of Tunis (Tr-May 26.) 1200 w.

*13383. Primitive Art in Egypt, with Discussion. W. M. Flinders Petrie (J S A-May 26.) 4300 w.

13396. Curves. Ill. F. H. Doane (E A-June 10.) 900 w.

13426. Harvesting India Rubber in South America (M & B-May.) 800 w.

13427. Luminous Paints. J. E. Smith (M & B-May.) 700 w.

13435. The World's Columbian Exposition. Ill. J. D. (Sc A S-June 10.) 8000 w.

†13464. Weights and Measures of the United States. T. C. Mendenhall (T Q-Dec.) 3000 w.

13477. Charges for Power at the World's Fair. Editorial (R G-June 9.) 900 w.

Serials.

9401. World's Columbian Exposition (E N-Began Jan. 5—13 parts to date—15 cts. each).

11978. Some of my Experiences as an Engineer on the Niger. John Parkin (E G-Began April—3 parts to date—30 cts. each).

12382. The Ideal Engineering School (E N—Began April 27—5 parts to date—15 cts. each.)

12477. Argentine (Eng L—Began April 21—Ended May 26—3 parts—30 cts. each).

12540. Early Engineering Reminiscences. George Escol Sellers (A M—Began May 4—Ended June 8—3 parts—15 cts each).

12695. Atomic and Molecular Motions. A. E. Dolbear (E N Y—Began May 10—3 parts to date—15 cts. each).

12812. The Interdependence of Abstract Science and Engineering. William Anderson (Eng L—Began May 5—Ended May 12—2 parts—30 cts. each).

13186. Practical Designing. Ill. Gleeson White (B A—Began May 19—2 parts to date—30 cts. each).

13211. The Seven Ages of Art. E. G. Lind (S A—Began June—1 part to date—15 cts).

13408. Scraps from an Engineer's Note Book (A M S—Began April 22—1 part to date—30 cts).

NEW BOOKS OF THE MONTH.

[For the convenience of readers any American books will be supplied at publishers' prices by The Engineering Magazine Co. Foreign books, 25 per cent. extra.]

Baldwin Locomotive Works Exhibit at the World's Columbian Exposition. Philadelphia: Lippincott. [Cloth, 78 p.]

Bottone, S. R.=Electricity and Magnetism. London: Whittaker and Co. [8vo, cloth, 198 p., $1.]

Carpentry for River and Garden. New York: Ward, Lock, Bowden & Co. [12mo, cloth, 250 p., 40 cts.]

Catalogue of City, Park and Sewer Castings, Road Rollers, Crushers, etc. Allegheny, Pa.: Thomas Carlin's Sons. [16 p. Free on application.]

Catalogue of Coal Mining Machines; Elevating and Conveying Machinery. Columbus, O.: The Jeffrey Manufacturing Co. [Paper, 96 p. Free on application.]

Cox, William.=The Slide Rule: Including Description and Method of Using the "Duplex" Slide Rule,—an improved form of the "Mannheim." Of Great Value to Mechanical and Civil Engineers. New York: Keuffel & Esser Co. [8vo. 44 p., 75 cts.]

Dibble, F. L.=Vagaries of Sanitary Science. Philadelphia: Lippincott. [8vo, cloth, 464 p., $2.]

Kendall, J. D.=The Iron Ores of Great Britain and Ireland.—Their mode of occurrence, age, and origin, and the methods of searching for and working them. London: Lockwood. [8vo, 424 p., 16s.]

Loney, S. L.=Mechanics and Hydrostatics for Beginners. New York: Macmillan. [16mo, 304 p., cloth, $1.25.]

Low, David Allen, and Bevis, Alfred W.=A Manual of Machine-Drawing and Design. New York: Longmans, Green & Co. [8vo, 373 p., cloth, $2.50.]

Manual of Guard Duty, U. S. Army. New York: Army and Navy Journal. [32mo, boards, 78 p., 25 cts.]

Manufacturers of the United States. New York: Manufacturers' Publishing Co. [4to., cloth, 1800 p., $10.]

Martin, Franklin H.=Electricity: Diseases of Women and Obstetrics. Chicago: The W. T. Keener Co. [8vo, cloth, 266 p., $2.]

Maycock, W. Perren.=Electric Lighting and Power Distribution.—Part II. London: Whittaker & Co. [12mo, 320 p., paper, 2s. 6d.]

McKinney, W. M.=American and English Railroad Cases. A collection of all the railroad cases in the courts of last resort in America and England. Northport, N. Y.: E. Thompson Co. [8vo, sheep, 710 p., $4.50.]

Mineral Industry (The); = Its Statistics, Technology, and Trade in the United States and Other Countries, from the Earliest Times to the End of 1892. Statistical Supplement of the Engineering and Mining Journal. One of the most important and valuable publications ever inaugurated. New York: Scientific Publishing Co. [8vo, 628 p., cloth, $2.50.]

Outerbridge, Alexander E.=The Modern Traveling Crane. Philadelphia: William Sellers & Co. [8vo, 11 p., free on application.]

Palmbery, Albert.=Treatise on Public Health and its Applications in Different European Countries—(England, France, Belgium, Germany, Austria, Sweden, and Finland). New York: Macmillan. [8vo, cloth, 559 p., $5.]

Poor, H. V.=Poor's Manual of the Railroads of the United States for 1893. In which is incorporated Poor's "Directory of Railway Officials and Directors." New York: H. V. & H. W. Poor. [8vo, cloth, $6.]

Practical Hints on Joint-Wiping for Beginners in Plumbing. New York: David Williams. [8vo, paper, 45 p., 25 cents.]

Renwick, E. S.=Patentable Invention. Rochester: The Lawyers' Co-operative Publishing Co. [12mo, sheep, 170 p., $2.]

Report of Commission Appointed to Investigate the Waste of Coal Mining, with the View to the Utilizing of the Waste. Philadelphia: Allen, Lane & Scott. [8vo, paper, 183 p.]

Schaeberle, J. M.=Terrestrial Atmospheric Absorption of the Photographic Rays of Light. Sacramento: State Printing Office. [8vo, cloth, 89 p.]

Searles, James M.=Life and Times of a Civil Engineer. Supplemented by the True Theory of the Mississippi River. Cincinnati: Robert Clarke & Co. [8vo, paper, 139 p.]

We supply copies of these articles. See introductory.

ARCHITECTURE.

*13495. Architecture at the World's Fair. Barr Ferree (E Mag-Aug.) 3000 w.

13504. Proportions of Cast Iron Bearing-Plates for Girders and Columns. Ill. F. E. Kidder (A A-June 10.) 1400 w.

*13512. Fire-Proof Buildings. J. E. Wadsworth (Y B S E-1893.) 4200 w.

†13606 Foundations, with Discussion. Ill. W. G. Wilkins (E S W P-April.) 5500 w.

†13607. An Improperly Designed Chimney. Ill. Gustave Kaufman (E S W P-April.) 2800 w.

13613. Dumb Waiter Shafts (Sc A-June 17.) 550 w.

13655. Architects and Sanitation (S P-June 15.) 1300 w.

*13667. Suggestions for Design from Foliage.—The Dock. Ill. (Pl D-June 1.) 1200 w.

*13668. Design in Decoration (Pl D-June 1.) 1400 w.

*13690. Architectural Disguises (Can A-June.) 1600 w.

13695. Lord Grimthorpe's Works at St. Albans Cathedral (A A-June 17.) 2600 w.

13696. The Accident at Ford's Theatre. Ill. (A A-June 17.) 1200 w.

13731. Copley Square.—The Architect's Suggestions for Its Improvement (B C-June 17.) 1600 w.

*13796. The Victoria House, Chicago. Ill. (B A-June 16.) 1000 w.

*13807. The Cipollino Marbles of Switzerland. Ill. (S-June.) 300 w.

*13808. Stone and Stonework. I. C. U. (S-June.) 1100 w.

*13810. Straight Heads or Flat Arches. Ill. (S-June.) 1700 w.

†13835. American Art Supreme in Colored Glass. Louis C. Tiffany (F-July.) 3300 w.

*13836. Chicago Architecture. Ill. Barr Ferree (L Mag-July.) 2800 w.

*13854. Washington. M. G. Van Rensselaer (A L-June 16.) 2400 w.

*13884. An Architect's Impressions at the World's Fair. Cass Gilbert (N W-May.) 1500 w.

*13885. The Use of Photography and Its Relation to Architecture. William Allport (N W-May.) 2100 w.

13914. The New Stock Exchange in Madrid. Ill. (Sc A S-July 1.) 250 w.

*14034 The Cliff Dwellers of New York. Ill. Everett N. Blanke (Cos-July.) 2800 w.

†14043. Color in the Court of Honor at the Fair. Ill. Royal Cortissoz (C M-July.) 3000 w.

14049. Air as a Timber Preservative (M N-July 1.) 600 w.

*14067. Address on the Presentation of the Royal Gold Medal at the R. I. B. A. J. MacVicar Anderson (B A-June 23.) 2500 w.

14074. German Apartment Houses (C & B-July) 1000 w.

*14098. Résumé—Roman Architecture. Viollet-leDuc (J A-April.) 2500 w.

14106. The New York "Herald" Building. Ill. (E R-July 1.) 3800 w.

14150. Test of Bearing Power of Piles. Ill. (E N-July 6.) 850 w.

*14164. Decorative Woodwork Stains. Frederick Parsons (B & D-June.) 1000 w.

14179. Notes on Gesso-Work. Walter Crane (A A-July 8.) 2000 w.

14195. Colors of the Ancients (O P D R-July 10.) 750 w.

Serials.

2285. Construction. Ill. M. Viollet-le-Duc (A A-Began Feb. 1892—22 parts to date—15 cts. each).

7121. Office-Helps for Architects. Ill. George Hill (A A-Began Oct. 8—14 parts to date—15 cts. each).

10682. The Chateaux of France. Ill. Louis H. Gibson (S-Began Feb.—5 parts to date—30 cts. each).

12415. Topographical and Architectural History of the City of Mexico. Arthur Howard Noll (A A-Began April 29—2 parts to date—15 cts. each).

12425. The Weathering of Building Stones. George P. Merrill (S-Began April—3 parts to date—30 cts. each).

12568. Building Construction and Superintendence. F. E. Kidder (A & B-Began May 6—5 parts to date—15 cts. each).

12963. Commemorative Monuments. Ill. L. C. Boileau (A A-Began May 20—6 parts to date—15 cts. each).

12966. Another Architectural Knock-About. Ill. F. L. V. Hoppin (A A-Began May 20—7 parts to date—15 cts. each).

13093. Laying Steel Roofing. Ill. L. S. Bonbrake (Met W-Began May 27—Ended July 8—4 parts—15 cts. each).

13536. The Grievances of Building Workmen (A L-Began June 2—2 parts to date—30 cts. each).

13712 Notes, Principally on English "Geometrical Decorated" Windows (A L-Began June 9—3 parts to date—30 cts. each).

13755. The Best Disposition of Iron Joists for Floors of Irregular Shape. Ill. A. (I E-Began May 20—2 parts to date—45 cts. each).

13795. The Open Fireplace, Past and Present. John Ward (A & B-Began June 24—Ended July 8—2 parts—15 cts. each).

13886. Architecture. Inaugural Address of W. G. Dauncey (N W-Began May—1 part to date—30 cts).

13919. The Use and Abuse of Precedent. Ill. A. Langford Warren (A Rev-Began Feb. 13—1 part to date—45 cts).

14018. Geometry in Design. H. A. Saunders (A L-Began June 23—1 part to date—30 cts).

14063. Mosaic: Its History and Practice.

C. Harrison Townsend (J S A-Began June 23—1 part to date—30 cts).

14176. Doorways. Ill. E. Rivoalen (A A-Began July 8—1 part to date—15 cts).

CIVIL ENGINEERING.

*13490. Railway Terminals and New York Harbor. W. N. Black (E Mag-Aug.) 3000 w.

*13521. The Austin Masonry Dam. Ill. D. Cuyler Washburn (Y B S E-1893.) 900 w.

*13580. The Manchester Ship Canal. Ill. (Eng L-June 2.) 1800 w.

13612. Germany's Highest Bridge. Ill. (Sc A-June 17.) 400 w.

13614. The Moles of Saint Jean-de-Luz. Ill. (Sc A S-June 17.) 1700 w.

13623. A Proposed New Type of Dam. Ill. (E N-June 15.) 1200 w.

*13682. The Regularization of the Danube. Ill. (E-June 9.) 3500 w.

*13684. Foundation for 130-ton Crane at Glasgow Harbor. Ill. (E-June 9.) 2000 w.

*13698. The Harbor Works at Alexandria (Tr-June 9.) 1600 w.

*13714. Lambeth and Vauxhall Bridges (A L-June 9.) 1500 w.

*13724. Wreck Raising in the River Thames (I C T-June 9.) 1200 w.

*13770. Famous Roads of Union County. Ill. C. C. McBride (G R-June.) 3500 w.

*13771. New Jersey Road Legislation. Ill. Franklin Dye (G R-June.) 2000 w.

13776. The San Blas Ship Canal Project. Ill. Amos G. Hull (E N-June 22.) 2800 w.

13793. Our Need of Good Roads (M R-June 23.) 1600 w.

†13906. The Improvement of James River, Virginia. Ill. H. D. Whitcomb (T C E-April.) 10400 w.

13915. The Proposed Overhead Mersey Bridge. Ill. (Sc A S-July 1.) 700 w.

13970. A Possible Solution to the Mississippi Levee Problem. George B. Boomer (M R-June 30.) 1300 w.

13975. New Tunnel on the London and Northwestern Railway. Ill. Henry J. Bridgewater (E N-June 29.) 2200 w.

13977. Recent Practice in Dry Dock Construction. Ill. (E N-June 29.) 4400 w.

13980. Surveys and Borings for the Prince Edward Island Tunnel. Ill. (E N-June 29.) 2000 w.

13982. The Austin Dam Accident (E N-June 29.) 2500 w.

*14022. New Stadia Charts. Edward P. Morris (J A E S-May.) 1000 w.

*14024. Sidewalk Improvements in the Vicinity of Cincinnati. E. F. Layman (P-July.) 2500 w.

ELECTRIC LIGHTING.

*13706. Prof. Perry's Electricity Meter. Ill. (E E L-June 9.) 800 w.

*13718. The Price of Electric Supply. E. Tremlett Carter (El-June 9.) 3500 w.

*13719. Electrostatic Voltmeters. Editorial (El-June 9.) 1200 w.

*13744. Incandescent Lighting in the Navy (G E M-June 10.) 1200 w.

13799. Care of Arc Lamps. D. Rivers (S E-June 10.) 800 w.

*13848. Electric Lighting in London—The Amberley Road Station. Ill. (Eng L-June 16.) 2000 w.

*13850. The Electric Lighting of Buda-Pesth. Ill. (E R L-June 16.) 1500 w.

13898. The Gas Engine in Electric Lighting. Editorial (E E N Y-June 28.) 900 w.

*14010. The Electric Lighting of Zuami (E R L-June 23.) 700 w.

14013. The Electric Plant of Chur, Switzerland. Ill. (E W-July 8.) 1600 w.

14014. Electric Lighting in Europe. (Abstract.) William McDevitt (E W-July 8.) 2500 w.

14145. Electrical Installations and Some Radical Changes in General Systems of Wiring. Ill. C. G. Armstrong (C E N-July.) 3900 w.

*14202. The Jamestown, New York, Municipal Lighting Plant (E I-July.) 1000 w.

Serials.

6709. Electric Light and Power. Ill. Arthur F. Guy (E E L-Began Sept. 9—22 parts to date—30 cts. each).

13548. Arc Lighting. E. Tremlett Carter (E R L-Began June 2—4 parts to date—30 cts. each).

13588. The Economy of Small Lighting Stations. James B. Cahoon (E W-Began June 17—2 parts to date—15 cts. each).

GAS ENGINEERING.

*13573. Large Gas Engines vs. Steam Power (E M-June.) 1200 w.

13617. Early History of Wrought Iron Gas Pipe. B. T. Crane (Ir Age-June 15.) 2000 w.

*13759. Inaugural Address of Denny Lane, at Belfast (J G L-June 13.) 10500 w.

*13960. Gas Fittings and Their Supply by Gas Undertakings. John Lyne (G E M-June.) 3400 w.

*13961. The Enrichment of Coal Gas, with Discussion. Vivian B. Lewes (G E M-June.) 6000 w.

*13962. Gas Lighting and Ventilation. Vivian B. Lewes (G E M-June.) 7400 w.

*13963. Rotary Engines and Their Application to Gas Exhaustion, with Discussion. Ill. E. Bryan Donkin (G E M-June.) 5000 w.

*13964. On the Setting and Working of Inclined Retorts at Middlesborough, with Discussion. D. Terrace (G E M-June.) 3800 w.

*13965. Gas Power, with Discussion. Ill. J. Emerson Dawson (G E M-June.) 7000 w.

*14077. Position and Prospects of the Gas Supply. Editorial (Eng L-June 23.) 2300 w.

Serials.

13534. The Gas Engine. Ill. (M W–Began June 2—1 part to date—30 cts).

13760. The Suggested Federation of Gas Managers' Association. Norton H. Humphreys (J G L–Began June 13—Ended June 27—3 parts—30 cts. each).

13881. Labor Saving-Appliances in Gas-Works. Ill. (I & I–Began June 16—1 part to date—30 cts).

HYDRAULICS.

13507. The Question of Pure Water for Philadelphia (F W–June 10.) 1800 w.

13624. Water-Works Intakes on Lake Michigan (E N–June 15.) 800 w.

13634. The 54-in. Steel Submerged Pipe for the Syracuse Water Works. Ill. (E N–June 15.) 2700 w.

13657. Something About Turbine Wheels (T–June 15.) 900 w.

13742. The Centrifugal Pumping Plant at Mare Island Navy Yard. Ill. John H. Cooper (A M–June 22.) 1600 w.

13779. "Is the Game Worth the Candle?" John Thomson (E N–June 22.) 3000 w.

†13907. The Old Time Water-Wheels of America, with Discussion. Ill. Joseph P. Frizell (T C E–April.) 5500 w.

†13909. Discussion on "The Effect of Tuberculation on the delivery of a 48-in. Water Main," by J. Duane (T C E–April.) 7000 w.

*14078. Egypt. Editorial (Eng L–June 23.) 2200 w.

14105. The Municipal Power, Light and Water-Works of Austin, Tex. Ill. (E R–July 1.) 2000 w.

*14130. Water-Meters for Municipal Purposes (J G L–June 27.) 2000 w.

†14138. Irrigation in Sind (I E–June 3.) 700 w.

*14148. Some Problems in Pumping Fluids. Ill. J. Richards (I S F–July.) 3500 w.

14156. The New Water-Works Pumping Station at Marlborough, Mass. Ill. (E N–July 6.) 500 w.

14159. Troy's New Water Supply (F W–July 8.) 800 w.

Serials.

12685. Development of Modern Steam Pump. Wm. M. Barr (E Mag–Began July—Ended Aug.—2 parts—30 cts. each).

13628. The Works of the East Jersey Water Co. for the Supply of Newark, N. J. (E N–Began June 15—2 parts to date—15 cts. each).

13702. Hydraulic Lifts. Robert Carey (M W–Began June 9—3 parts to date—30 cts. each).

INDUSTRIAL CHEMISTRY.

*13523. The Chemistry of Iron. J. Frank Corbett (Y B S E–1893.) 2000 w.

14136. Notes on Chemical Manufacturing in Russia. R. Bowman (Sc A S–July 8.) 2500 w.

Serials.

12603. Facts and Figures on Electrolytic Chlorine and Soda. Emile Andreoli (E R L–Began April 28—Ended June 2—4 parts—30 cts. each).

INDUSTRIAL SOCIOLOGY.

*13493. Labor Legislation in England. R. S. Viktorov (E Mag–Aug.) 4000 w.

*13494. The Unit of Value in All Trade. Edw. Atkinson (E Mag–Aug.) 5000 w.

†13497. The Eight-Hours' Day and the Unemployed. John Rae (C R–June) 9300 w.

*13543. Syndicated Production and Distribution of Commodities. Editorial (I L–June 2.) 1500 w.

*13564. Labor Questions in Australasia. Editorial (E–June 2.) 2500 w.

†13582. Six Hundred Years of English Poverty: A Study in the Fluctuations of the Purchasing Power of Wages. Gustav F. Steffen (N C–June.) 8500 w.

†13583. How to Attract Capital to the Land. Lord Vernon (N C–June.) 4800 w.

*13663. Profit Sharing Explained and Defended. Review of book by T. W. Bushill (J G L–June 6.) 2000 w.

13794. One Industrial Problem. A. B. Salom (I I G–June.) 1200 w.

13842. The Wages Outlook. Editorial (A M & I W–June 23.) 900 w.

†13936. How Distrust Stops Trade. Edward Atkinson (N A R–July.) 2000 w.

†13937. The Anti-Trust Campaign. Albion W. Tourgee (N A R–July.) 5500 w.

†13939. Should the Chinese be Excluded? R. G. Ingersoll and T. J. Geary (N A R–July.) 7500 w.

*14000. The Labor Question in India. Editorial (E–June 23.) 2000 w.

*14033. Domestic Service. From the Standpoint of the Employee. Lucy M. Salmon (Cos–July.) 5000 w.

*14042. What Shall be Done with the Indian? From the Indian's Point of View. Chauncey Yellow Robe (N P R–July.) 1000 w.

†14044. Hostility of Foreign to American Labor (C M–July.) 1500 w.

14100. A Railroad Example. Editorial (A S–July 1.) 700 w.

14184. Some Things Employés do not Share. Editorial (I T R–July 6.) 600 w.

14201. Aid for the Unemployed (B J C–July 8.) 1000 w.

*14025. Tests of Paving Brick (P–July.) 1500 w.

*14026. Street Paving in Australian Cities. George H. Wallace (P–July.) 1500 w.

*14027. Street Paving in Boston (P–July.) 1200 w.

14152. The North Ave. Masonry Arch Bridge, Baltimore, Md. Ill. (E N–July 6.) 2000 w.

14167. How to Stop Levee Breaks. A. W. Soule (M R-July 7.) 600 w.

14185. Moving Loads for Railway Bridges, with Editorial. J. A. L. Waddell (E R-July 8.) 3000 w.

Serials.

11182. The Nicaragua Canal (E-Began Feb. 24—Ended June 16—6 parts—30 cts. each).

13009. Strains in Beams and Girders. Ill. John Wright Seaver (E R-Began May 20—3 parts to date—15 cts. each).

13194. Highway Bridges. Ill. John N. Ostrom (G R-Began May—2 parts to date—30 cts. each).

13420. The Sher Shah Bridge, over the River Chinab near Multan, Punjab. Ill. Francis J. E. Spring (I E-Began May 6—Ended May 13—2 parts—45 cts. each).

13772. The Road System of Union County. Ill. F. A. Dunham (G R-Began June—1 part to date—30 cts).

13773. The Birthplace of American Road Improvement. Ill. James Owen (G R-Began June—1 part to date—30 cts).

ELECTRICAL MISCELLANY.

*13491. Electricity in the Home and Office. F. A. C. Perrine (E Mag-Aug.) 3000 w.

*13496. The Power Plant at the World's Fair. Ill. W. S. Monroe (E Mag-Aug.) 4000 w.

*13511. Electricity in Agriculture. George D. Shepardson (Y B S E-1893.) 3000 w.

*13517. The Electrical Engineer and His Work. George D. Shepardson (Y B S E-1893.) 4800 w.

*13520. An Experiment in Electric Resonance. Ill. A. Zileny (Y B S E-1893.) 500 w.

*13538. Effects Produced by Using an Inductionless Shunt with a Choking Coil. Ill. Hugh Erat Harrison (El-June 2.) 1200 w.

*13539. Some Experiments on the Electrochemical Equivalent of Zinc. James Erskine Murray (El-June 2.) 800 w.

*13550. Rotary Magnetic Fields. Ill. Alexander Russell (E R L-June 2.) 800 w.

*13565. The Control of Sparking in Short Air-Space Dynamos. Ill. (E-June 2.) 2300 w.

*13571. Prof. Kennedy's Report on Tests of Steam Dynamo at Thames Ditton, May 20, 1893 (E E L-June 2.) 900 w.

13586. The Outlook for Electrical Engineers. Editorial (E E N Y-June 14.) 1000 w.

13587. Electrical Engineering at the University of Nebraska. Ill. R. B. Owens (E E N Y-June.) 2000 w.

13589. Temperature Error in Electrical Instruments. W. M. Hill (E W-June 17.) 1200 w.

13609. The Edge of the Future. Unsolved Problems that Edison is Studying. E. J. Edwards (E A-June 17.) 1900 w.

13645. Electric Heating. Ill. W. S. Key (E N Y-June 14.) 1500 w.

*13673. The Tendency in Central Station Design. Editorial (I L-June 9.) 1200 w.

13686. The Earth as an Electrical Conductor. A. F. McKissick (Sc-June 16.) 700 w.

13701. Advances in Electric Heating (A G L J-June 19.) 1400 w.

*13707. An Automatic Switch for Transformers. Ill. (E E L-June 9.) 1200 w.

*13715. A Curious Transformer Experiment. Ill. Rankin Kennedy (E R L-June 9.) 500 w.

*13717. The Advantage of High Tension in Distribution (E R L-June 9.) 900 w.

*13720. Dynamos, Alternators and Transformers—Review of book by Gisbert Kapp. A. T. S. (El-June 9.) 2000 w.

13735. Electrolytic Action of Heavy Currents on Water and Gas Pipes. Cromwell Galpin (E R N Y-June 24.) 1200 w.

13736. Motors for Alternating Currents. Ill. F. H. Leonard, Jr. (M S R-June 15.) 1200 w.

13738. Lieut. Fiske's Depression Position Finder. Ill. (E E N Y-June 21.) 1500 w.

13739. A Simple Method of Calculating Joint Resistances. William C. Ramsdell (E E N Y-June 21.) 700 w.

13762. Effective Alternating Currents and Electromotive Forces. A. E. Kennelly (E W-June 24.) 700 w.

13767. Electrolysis in the Production of Silver. F. M. F. Cazin (E A-June 24.) 1000 w.

*13803. The Faure-Sellon-Volckman Patents in the French Courts. Ch. Haubtmann (El-June 16.) 1800 w.

*13804. Comparisons between the Different Systems of Distributing Electricity. H. Robinson (El-June 16.) 5000 w.

*13843. The Accumulator (Eng L-June 16.) 1800 w.

*13860. Multiplication of the Number of Periods of Linuvoidal Currents. Désiré Korda (E E L-June 16.) 800 w.

13861. A Study in Polarization. John Daniel (Sc-June 23.) 1500 w.

13883. Electric Heating (B C-June 24.) 1500 w.

13895. Otis Elevators Controlled by the Leonard Method, in the American Theatre. Ill. (E E N Y-June 28.) 900 w.

13896. Statistics of Fires Caused by Electric Currents. G. S. Boudinot (E E N Y-June 28.) 600 w.

13900. Electro-Chemical Effects Due to Magnetization. George Owen Squier (E R N Y-July 1.) 6300 w.

13901. Fundamental Laws in Electro-Dynamics. Ill. B. B. James (E W-July 1.) 2000 w.

13902. The Accumulator in Commercial Work. List Prepared by J. Stanford Brown (E W-July 1.)

*14004. Electric Crane on Southampton Quay. Ill. (I & I-June 23.) 1500 w.

*14009. The Trumpy Automatic Accumulator Regulator. Ill. (E R L-June 23.) 1200 w.

*14011. Electrical Oscillations of Low Frequency and their Resonance (E R L–June 23) 1200 w.

14015. Benson Bidwell and his Electrical Inventions. Ill. Charles Freeman (E W–July 8.) 1500 w.

*14046. Electricity at the World's Fair. Ill. J. R. Cravath (R of R–July.) 3000 w.

*14047. Two Giants of the Electric Age. Thomas A. Edison, by Charles D Lanier, and Sir William Thomson, Lord Kelvin, by J. Munro. Ill. (R of R–July.) 20000 w.

14052. Electricity as a Fire Hazard. C. J. H. Woodbury (M G–July 1) 1200 w.

*14062. Electrical Communication between Light Vessels, Rock Stations, and the Mainland. John Rochford (E E L–June 23.) 1700 w.

*14075. Luminosity in Vacuum Tubes. Ill. E. C. Rimington (El–June 23.) 2200 w.

*14076. Instrument for Testing Primary Batteries. Ill. (El–June 23.) 700 w.

14114. Formulæ for Calculating the Diameter and Length of an Armature. Arranged from Gisbert Kapp's "Transmission of Energy" (E E N Y–July 5.) 1500 w.

14144. The Testing of Dynamos and Motors. Hazen Ritchie (C E N–July) 1000 w.

14168. Electrical Shop Equipments (E N Y–July 5.) 1800 w.

Serials.

11501. Theory of the Transformer. Ill. F. Bedell and A. C. Crehore (E W–Began March 25—5 parts to date—15 cts. each).

11560. Electricity as a Motive Power. Ill. Albion T. Snell (El–Began March 17—6 parts to date—30 cts. each).

12668. Non-Synchronous Alternating Current Motors. H. Behn-Eschenburg (E W–Began May 13—3 parts to date—15 cts. each).

13013. Alternate Current Transformer Design. Ill. R. W. Weekes (E E L–Began May 12—6 parts to date—30 cts. each).

13591. Long Distance Electric Transmission of Power. W. F. C. Harrison (E W–Began June 17—2 parts to date—15 cts. each).

13710. The Development of the Electrical Engineering Industry. R. Percy Sellon (E P–Began June—1 part to date—30 cts).

13800. Single Electro-Motor Working, with Editorial. Ill. Mr. Richter (E L–Began June 10—3 parts to date—30 cts. each).

MARINE ENGINEERING

13499. Types of Ocean Going Cargo Steamers. Ill. (M R C–June 8.) 450 w.

13500. Most Powerful Boat on the Lakes. Car Ferry Sante Marie. Ill. (M R C–June 8.) 500 w.

*13533. The New Route to the Continent (Tr–June 2.) 800 w.

13704. The Pacific Coast Trade. Editorial (M Rec–June 15.) 1400 w.

13732. The Trinidad Line's New Steamship "Creole Prince." Ill. (Am S–June 22.) 600 w.

13741. The Work of the New York Dock Department (R G–June 16.) 1800 w.

13745. The Viking Ship for the Columbian Exposition, with Editorial. Ill. (Sc A–June 24.) 1100 w.

13747. The New Port of Tunis. Ill. (Sc A S–June 24.) 2000 w.

13766. Four Days Across the Atlantic. Editorial (Ir Age–June 22.) 900 w.

†13768. Caught on a Lee Shore. Pleasures and Perils of a Cruise on the Florida Coast. Ill. William Henn (C M–June.) 9000 w.

13781. Shipbuilding on the Coast of the Pacific. G. W. Dickie (Sea–June 22.) 2000 w.

13782. Angry Towboatmen. Regarding Lights Carried on Mastless Vessels (Sea–June 22.) 3000 w.

*13812. The Life of the Merchant Sailor. Ill. W. Clark Russell (Sc M–July.) 7000 w.

13918 Visit to the Viking Ship (Am S–June 29) 500 w.

13927. The Boatmen's Fight.—Safe Lights on Mastless Vessels in Tow Their Only Contention (Sea–June 29.) 2500 w.

13928 Fishing Banks' Boats. Ill. (Sea–June 29.) 1200 w.

13929. Steam Yachts.—Floating Palaces for our Millionaires (Sea–June 29.) 900 w.

†13941. International Yachting in 1893. George A. Stewart (N A R–July.) 3200 w.

*14001. The Possibilities of Speed on the Atlantic. Editorial (E–June 23.) 1800 w.

*14064. The Liverpool of the East. A Policy of Despair (Tr–June 23.) 1800 w.

14101. Petroleum in Marine Locomotion (A S–July 1.) 700 w.

14104. Deep-Water Harbors on the Texas Coast. Editorial (E R–July 1.) 600 w.

*14112. The Lubrication of Marine Engines. W. M. Ross (A E R J–July.) 1500 w.

14183. The Navahoe. Ill. (M Rec–July 6.) 900 w.

14196. Waterspouts at Sea.—Thrilling Experiences of Two Vessels (B J C–July 8.) 900 w.

*14203. Broken Propeller Shafts. Editorial (I & I–June 30.) 900 w.

Serials.

12250. Capt. Alexander McDougall's Patents. Ill. (M R C–Began April 20—9 parts to date—15 cts. each).

12961 Steel Ship Construction (M R C–Began May 18—3 parts to date—15 cts. each).

13393 The Lubrication of Marine Engines (M W–Began May 26—Ended June 2—2 parts—30 cts. each).

13443. Our Flag at Sea. William W. Bates (Sea–Began June 8—3 parts to date—15 cts. each).

13917. The Development of the Steamship. Horace See (Am S–Began June 29—2 parts to date—15 cts. each).

MECHANICAL ENGINEERING.

13605. Molding a Condenser. Ill. Joseph Horner (A M–June 15.) 1900 w.

13783. Counter-Shafts. C. R. Tompkins (M N–June 15.) 1200 w.

13841. A Curious Exposition Incident.—Starting the Ferris Wheel. E. C. P. (A M & I W–June 23.) 700 w.

13869. Rope-Power Transmission.—The English and American Systems (B J C–June 24.) 2000 w.

13912. The Great Wheel at Chicago. Ill. (Sc A–July 1.) 1500 w.

13920. Die Sinking.—Using the Die Sinking Machine. B. F. Spalding (A M–June 29.) 2000 w.

13923. Estimating Cost of Special Machines (Ir Age–June 29.) 600 w.

*13972. Durability of Hollow Bolts. Editorial (L E–July.) 650 w.

14073. Hints on Pattern Making (C & B–July.) 1800 w.

14197. The Big Ferris Wheel (B J C–July 8.) 1000 w.

Serials.

11246. Mechanical Engineering Materials. Edward C. R. Marks (P Eng–Began March 3—6 parts to date—30 cts. each).

12142. On Machine Designing (M W–Began April 7—5 parts to date—30 cts. each).

13181. Machine Tools. A. C. Amos (I–Began May 19—Ended June 9—3 parts—30 cts. each).

METALLURGY.

13509. The Passing of Iron. William Forsyth (R A–June 9.) 2500 w.

*13522. The History of Pig Iron. Peter H. Christianson (V B S E–1893.) 3300 w.

*13524. The Bessemer Process. Harry E. White (V B S E–1893.) 1200 w.

*13528. On the Hardening of Steel. W. Metcalf and J. W. Langley (P Eng–June 2.) 1800 w.

*13529. The Determination of Chromium in Ferro-Chromium. William Galbraith (I–June 2.) 2000 w.

*13530. Methods of Determining Chromium with Notes on the Distribution of Chromium in British Irons. J. E. Stead (I–June 2.) 5500 w.

*13549. Electricity in Metallurgical Operations: Laboratory Furnaces. Ill. (E R L–June 2.) 900 w.

*13553. Discussion of Messrs. Stead's and Saniter's Papers on the Desulphurizing of Iron (C G–June 2.) 5800 w.

*13554. Notes on Puddling Iron, with Discussion. John Head (C G–June 2.) 4200 w.

*13555. The Northwest Hematite Trade (C G–June 2.) 1700 w.

*13579. The Development of the Use of Aluminium (Eng L–June 2.) 2500 w.

*13596. An Important Invention.—A Slag Steam Generator (A M S–April 29.) 1300 w.

*13597. The Junction Company's Smelters, Port Adelaide.—Treatment of Broken Hill Sulphides (A M S–April 29.) 1200 w.

13652. Some Alabama Iron Notes.—The Barton-McCormick Process for Magnetizing Hematite Ores (E M J–June 17.) 850 w.

*13659. Manufacture of Coke. Charles S. Preston (S J E–June.) 1400 w.

13685. Reverbatory Furnaces. Ill. John Pettigrew (F D–June.) 1700 w.

13722. The Iron Industry in Mexico. Ill. Joseph Parkes (A S–June 17.) 1000 w.

13723. Case-Hardening.—The Utility of the Process and Various Methods of Performing It. B. F. Spalding (A S–June 17.) 2000 w.

*13725. On Combustion in the Hearth of the Blast Furnace (I & S–June 10.) 1600 w.

*13726. The Influence of Cold on the Strength of Iron and Steel. E. Kuczera and Eugene Reinisch (I & S–June 10.) 700 w.

*13727. On the Comparative Longitudinal and Transverse Strength of Mild Steel. F. Kintzle (I & S–June 10.) 500 w.

*13728. On the Hardening of Steel (I & S–June 10.) 1800 w.

13737. Sampling Ores Without Use of Machinery. W. Glenn (M S R–June 15.) 2000 w.

13746. Where Tin Comes From (Sc A–June 24.) 1000 w.

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*13811. Lining Up an Engine. Robert Grimshaw (S-June.) 1900 w.

13828. Selecting an Engine. W. H. Wakeman (M G–June 24) 800 w.

13868. Firing with Natural Draft. Paris, Texas (B J C–June 24.) 1000 w.

*13925. Water-Hammers (R M–June.) 800 w.

*13971. Smoke Preventing.—Jim Skeevers and the Fourth Vice Try Experiments. (Humorous) (L E–July.) 2700 w.

*14005. Triple-Expansion Engine Economy. Editorial (I & I–June 23.) 1000 w.

*14019. A Comparative Test of Types of Smokeless Furnaces. John C. McMynn (J A E S–May.) 1800 w.

*14020. Steam Engine Efficiency—Its Possibilities and Limitations. William H. Bryan (J A E S–May.) 3000 w.

14056. Steam Consumption of an Engine.—How it is Measured from the Indicator Diagram. Ill. (B J C–July 1.) 2600 w.

14070. Boiler Steel. Samson Fox (R R–July 1.) 1500 w.

14107. Boiler Insurance (E R–July 1.) 700 w.

*14111. The Cyclogram of Pressures in Steam Engines. Ill. F. Edwards (A E R J–July.) 700 w.

14121. Engines at the World's Fair. Ill. (P S–July.) 14000 w.

*14129. On the Composition of Smoke. M. P. Laktine (J G L–June 27.) 1400 w.

14146. The Corliss Engine. Ill. Thomas Hawley (C E N–July.) 2800 w.

14186. Massachusetts Law for the Production of Smoke. Editorial (E R–July 8.) 650 w.

14198. Horse Power of a Boiler.—What it Means and How Figured (B J C–July 8.) 1000 w.

14199. Grooving in Steam Boilers. Ill. (B J C–July 8.) 1400 w.

14200. The Automatic Engine.—Its Peculiarities and Special Uses (B J C–July 8.) 750 w.

Serials.

11138. Notes on the Steam Injector. Ill. Strickland L. Kneass (E M–Began March—4 parts to date—30 cts. each).

12377. Steam Shovels and Steam Shovel Work. Ill. E. A. Hermann (E N–Began April 27—7 parts to date—15 cts. each).

13709. The Early Days of Steam Heating. James J. Walworth (E R–Began June 17—Ended June 24—2 parts—15 cts. each).

14040. The Steam Engine (T–Began July 1—1 part to date—15 cts).

TELEPHONY AND TELEGRAPHY.

*13526. The Transmission of Telephone Currents.—Review of book by W. J. Hopkins. Francis G. Baily (N–June 1.) 1000 w.

13585. Reminiscences of Sir J. Anderson. Ill. A. E. Kennelly (E E N Y–June 14.) 700 w.

13733. The Survey for the Pacific Cable (E R N Y–June 24.) 1600 w.

13734. Chinese Telegraph Lines (E R N Y–June 24) 450 w.

13787. New Chicago Office of the Western Union Telegraph Company. Ill. (W E–June 24.) 1500 w.

13968. Destruction of Telephone Cables by Electric Railway Currents. Ill. (W E–July 1.) 1200 w.

*14007. Electric Traction and Telephone Clauses (I & I–June 23.) 900 w.

*14012. Telephone Companies and Electric Traction (E R L–June 23.) 9900 w.

14115. The First Telegraph Money Order (E E N Y–July 5.) 200 w.

MISCELLANEOUS.

*13541. The Sheffield Technical School. Ill. (I L–June 2.) 5000 w.

*13547. Energy as a Fundamental Idea. E. Tremlett Carter (E R L–June 2.) 1000 w.

*13561. The Progress of the Columbian Exposition. J. D. (E–June 2.) 6400 w.

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†13592. Does the Country Demand Free Coinage of Silver? Who Are in Favor, and Who Opposed, and Why? A. C. Fisk (A–June.) 5200 w.

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13621. Interest. C. H. Aaron (M S P–June 10.) 2000 w.

*13675. The Regulation of Explosives. Editorial (Eng L–June 9.) 1800 w.

*13676. The Jury System and the Chicago Exhibition. Editorial (Eng L–June 9.) 800 w.

13775. The Hydraulic Laboratory and Courses of the Massachusetts Institute of Technology. Ill. (E N–June 22.) 2500 w.

13785. Making Silk from Wood (M N–June 15.) 900 w.

*13814. Foreground and Vista at the Fair. Ill. W. Hamilton Gibson (Sc M–July.) 3000 w.

*13824. Our Fire Appliances.—A Comparative Study of Ancient and Modern Implements and Machinery. Ill. (M–June 15.) 3400 w.

†13831. How the Fourth of July Should Be Celebrated. Julia Ward Howe (F–July.) 3500 w.

†13832. The World's Fair Balance-Sheet. Franklin H. Head (F–July.) 4000 w.

*13874. Exhibition of Fire-Extinguishing Appliances (E–June 16.) 1600 w.

*13875. The Columbian Relics at Jackson Park. J. D. (E–June 16.) 5500 w.

*13892. The Commerce of the Arctic Regions. Frederick Scwatka (G G M–May–June.) 1800 w.

*13893. Marvels of Mighty London (G G M–May–June.) 1500 w.

13899. The Paris Fire Alarm System. Ill. (E R N Y–July 1.) 600 w.

13903. A New Engineering Laboratory at the University of Pennsylvania. Ill. Edward T. Child (E W–July 1.) 850 w.

13913. The Needs and Opportunities of a Great Technical College. R. H. Thurston (Sc A S–July 1.) 4000 w.

†13938. Silver Legislation and Its Results. Edward O. Leech (N A R–July.) 4400 w.

†13942. The Family of Columbus. Duke of Veragua (N A R–July.) 2700 w.

†13943. Bimetallic Parity under a Gold Standard. C. Vincent (A–July.) 4300 w.

†13944. The Money Question. C. J. Buell (A–July.) 4300 w.

†13945. Crude Rubber in Many Lands. I. A. Sherman (I R W–June 15.) 1500 w.

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13986. Stoppage of Free Silver Coinage in India and Its Immediate Results (E M J–July 1.) 2200 w.

*14003. The World's Columbian Exposition. J. D. (E–June 23.) 6500 w.

*14030. A Turning Point in the Arts. Ill. Charles de Kay (Cos–July.) 4500 w.

*14032. Engineering with a Camera in the Cañons of the Colorado. Ill. Robert B. Stanton (Cos–July.) 4000 w.

*14045. An Englishman's Impressions at the Fair. Rev. F. Herbert Stead (R of R–July.) 4200 w.

14048. Wood Supplanted by Iron. Leicester Allen (M N–July 1.) 1500 w.

14050. A Monster Blast (M N–July 1.) 800 w.

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14103. The Young Graduate Engineer. Editorial (E R–July 1.) 900 w.

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*14147. Scandinavian Discovery of America (I S F–July.) 2600 w.

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14191. Engineers. W. H. Wakeman (M G–July 8.) 850 w.

Serials.

9401. World's Columbian Exposition (E N–Began Jan. 5—16 parts to date—15 cts. each).

11821. Causes of Fires. C. John Hexamer (J F I–Began April—Ended July—2 parts—45 cts. each).

12382. The Ideal Engineering School (E N–Began April 27—7 parts to date—15 cts. each).

13211. The Seven Ages of Art. E. G. Lind (S A–Began June—2 parts to date—30 cts. each).

13408. Scraps from an Engineer's Note Book (A M S–Began April 20—2 parts to date—30 cts. each).

13620. One Way to See the Exposition. Ill. Fred DeLand (W F E E–Began June—1 part to date—30 cts).

13703. The Dead-Meat Freezing Establishments on the River Plate. James Durie (M W–Began June 9—Ended June 16—2 parts—30 cts. each).

13905. From the Centennial Exposition to the World's Fair. Thomas D. Lockwood (E W–Began July 1—2 parts to date—15 cts. each).

13998. The Future of [illegible] Hot-Air Furnace A. W. Glessner (Met W–Began July 1—2 parts to date—15 cts. each).

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NEW BOOKS OF THE MONTH.

(For the convenience of readers any American books will be supplied at publishers' prices, by The Engineering Magazine Co. Foreign books, 25 per cent. extra.]

Baker, Edward.=Hand-book to Various Publications, Documents and Charts Connected with the Rise and Development of the Railway System Chiefly in Great Britain and Ireland. Birmingham. [120 p., 1s.]

Blyth, Wynter A.=Lectures on Sanitary Law. New York: Macmillan. [12mo, cloth, 298 p., $2.50.]

Catalogue of Blowers, Exhausters, Engines, Forges, and Heating and Ventilating Apparatus. B. F. Sturtevant Co. Boston. [200 p.—Free on application.]

Catalogue of Electric Railway Apparatus. Pittsburg: Westinghouse Electric and Manufacturing Co. [57 p.—Free on application.]

Catalogue of the New Laboratories of Case School of Applied Science. Cleveland, O. [Free on application.]

Delano, W. H.=Twenty Years' Practical Experience of Natural Asphalt and Mineral Bitumen. New York: Spon. [8vo, paper, 73 p., 50c.]

Engineer's and Draughtsman's Data-book for Workshop and Office Use. New York: Spon. [8vo, flex. leather, 122 p., $1.]

Grimshaw, Robert.=Locomotive Catechism. Containing over 1200 questions and answers concerning designing and construction, repairing and running of various kinds of locomotive engines. Intended as examination questions, and to post and remind the engine-runner, fireman, or learner. New York: Norman W. Henley & Co. [12mo, cloth, 360 p., $2.]

Haupt, Herman.=Street Railway Motors. With descriptions and cost of plants and operation of the various systems in use or proposed for motive-power on street railways. Philadelphia: H. Carey Baird & Co. [12mo, cloth, 213 p., $1.75.]

Heath, A. H.=A Manual on Lime and Cement; their Treatment and Use in Construction. New York: Spon. [12mo, cloth, 215 p., $2.50.]

Hobhouse, L. T.=The Labor Movement. With preface by R. B. Haldane. On the aims of labor, trade-unionism, co-operation, distribution of wealth, control of industry. Unwin. [8vo, 110 p., 3s. 6d.]

Millis, C. T.=Metal Plate-Work: Its Patterns and Their Geometry. Also, notes on metals and rules in mensuration for the use of tin, iron and zinc plate workers, coppersmiths, boiler-makers, plumbers, and others. New York: Spon. [12mo, cloth, 377 p., $3.50.]

Mines and Mining Men of Colorado: Historical, Descriptive and Pictorial. An account of the principal producing mines of gold and silver, the bonanza kings and successful prospectors, the picturesque camps and thriving cities of the Rocky Mountain Region. Denver: J. G. Canfield. [4to, morocco, 123 p., $2.50; paper, $1.]

Robinson, H.=Comparisons between the Different Systems of Distributing Electricity. New York: Spon. [8vo, 21 p., paper, 80c.]

Searles, J. M.=Life and Times of a Civil Engineer. Also—The True Theory of the Mississippi River. Cincinnati: Robert Clarke & Co. [12mo, paper, 139 p., $1.]

Simon, Andreas.=Chicago, the Garden City. Its magnificent parks, boulevards, and cemeteries, together with other descriptive views and sketches. Chicago: Koelling & Klappenbach. [8vo, paper, 248 p., 75 cts.]

Smith, Albert W.=Constructive Materials of Engineering. Palo Alto, Cal.: Palo Alto Press. [12mo, paper, 86 p., 80 cts.]

Swinburne, J., and Wordingham, C. H.=The Measurement of Electric Currents. Electrical Measuring Instruments, also Meters for Electrical Energy. New York: Van Nostrand. [32mo, 241 p., boards, 50 cts.]

The Electrician "Electrical Trades' Directory and Handbook for 1893." London: The Electrician Printing and Publishing Co. [8vo, 974 p., board, 7s. 6d., postage extra.]

Thompson, Silvanus P., and Smith, Eustace.=Electrical Tables and Memoranda. New York: Spon and Chamberlain. [64mo, roan, 128 p., 50 cts.]

Torrey, Augustus.=Switch Layouts; Showing graphically the leads, offsets, and all dimensions needed for locating frogs of all numbers and curves in all switches in common use, and Curve Easements; Tables of angles, chords and deflections for easing the transition from a tangent to a curve, and from a curve of one radius to a curve of another radius. A work especially valuable to section foremen and assistant engineers. New York: The Railroad Gazette. [12mo, leather, 195 p., $1.]

Wells, E. H.=New York Railroad Corporations. General railroad laws of New York, with decisions and forms; constitutional and statutory provisions affecting steam, street surface, "rapid transit," cable, electric, and other railroads, as found in the New York State constitution, the general corporation law, the stock corporation law, the railroad law, etc., with decisions, cross-references, and forms, also decisions under the "town bounding" acts. New York: Banks & Bros. [8vo, 699 p., sheep $2. paper $1.50.]

Westinghouse Electric Manufacturing Co.—Annual Report of the Board of Directors to the Stockholders. New York: C. G. Burgoyne. [Free on application.]

We supply copies of these articles. See introductory.

ARCHITECTURE.

*14209. The Need of Uniform Building Laws. William J. Freyer (E Mag-Sept.) 3000 w.

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*14699. The Cleveland Bridge and Engineering Co.'s Works, Darlington. Ill. (Eng L-July 21.) 1500 w.

*14730. Dover Harbor Extension. Ill. Editorial (E-July 21.) 1900 w.

*14731. The Extension of a Graving Dock at Leghorn, Italy. Ill. I. Inglese (E-July 21.) 2000 w.

*14761. The Proposed Deep Waterway from Buffalo to New York City, and Some Facts about the Suez Canal and the Numerous Projected American Isthmus Canals. Ill. John D. Estabrook (J A E S-June.) 9800 w.

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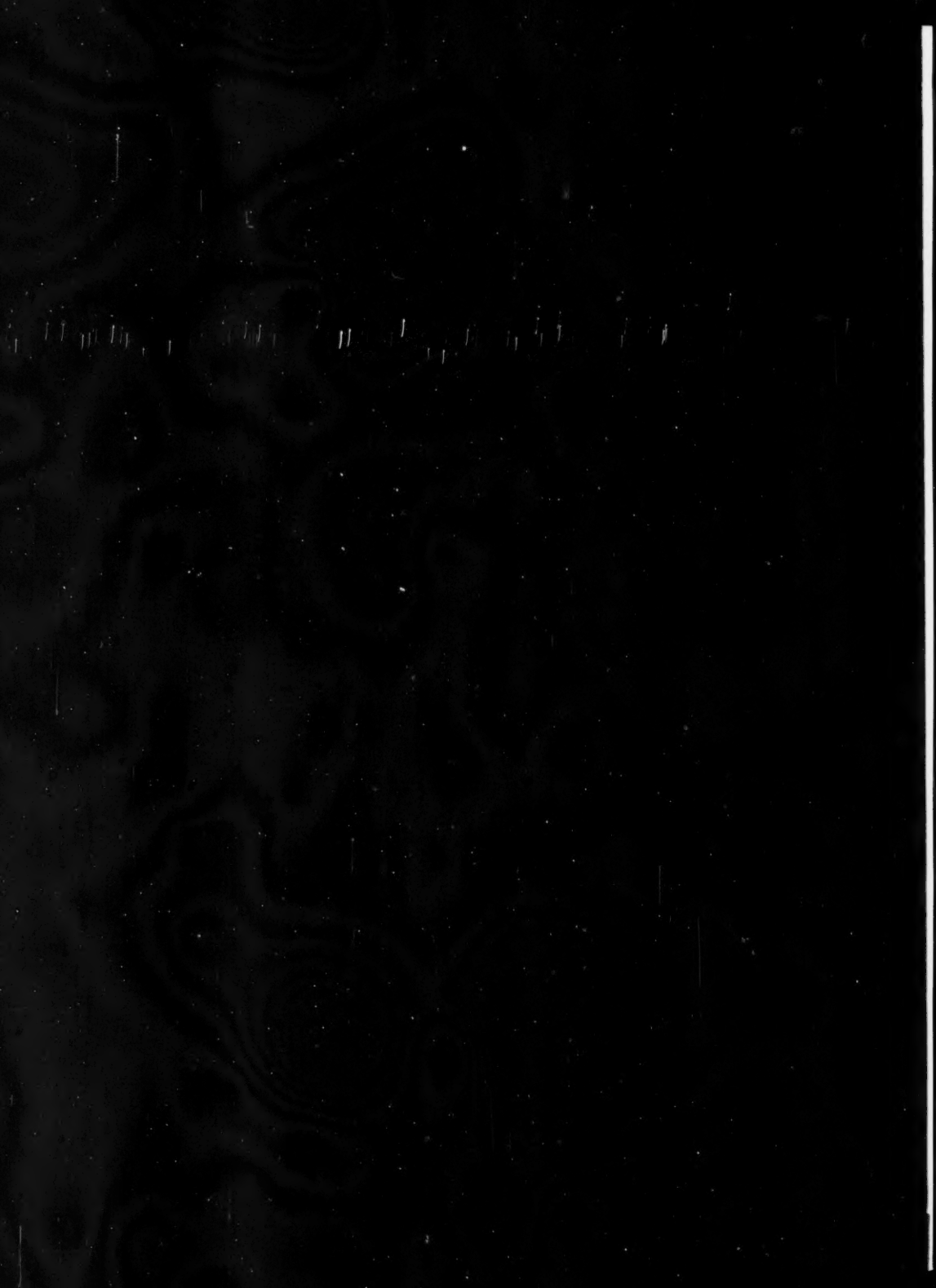

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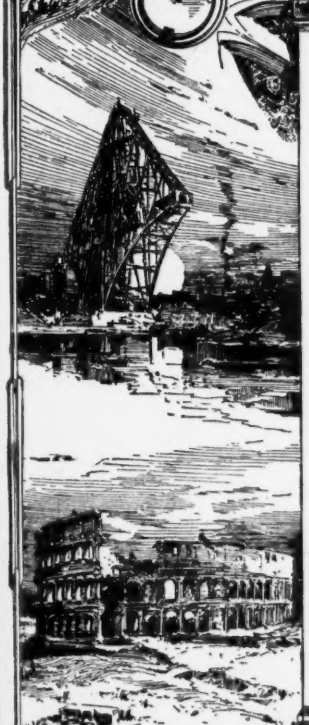

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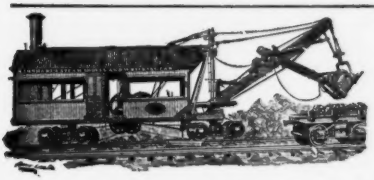

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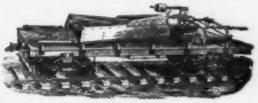

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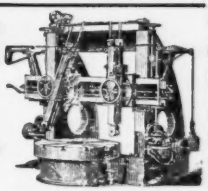

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A WORD OF INTRODUCTION.

AUTHORS AND PAPERS THIS MONTH.

M. J. FRANCISCO (*The Fallacy of Municipal Ownership*)=Born August 5, 1835, at Westhaven, Vt., where his father was the first preceptor of Horace Greeley, a native of the same town; was graduated from Oberlin College, in Ohio; principal of Northwestern Commercial College, Fort Wayne, Ind., 1860; raised volunteers for the Union cause in the civil war; president of Pennsylvania College of Trade and Finance, at Harrisburg, 1864; later was made manager for Vermont of several important fire-insurance companies, writing 130,000 policies; since 1887, president of the Rutland (Vt.) Electric Light Co.; is second vice-president of the National Electric Light Association; director in the Rutland Trust Co. and member of the Rutland Board of Trade; has written much on the fallacy of municipal ownership and is acknowledged to be the best authority on the subject.

WALKER KENNEDY (*Steamboating in the West and South*)=Born at Louisville, Ky., June 8, 1857; was connected with the Louisville *Courier-Journal* for four years; went to Memphis, Tenn., shortly after the last yellow-fever epidemic and has been connected with the press of that city ever since; for the last two years has been chief editorial writer on the *Appeal-Avalanche* of Memphis; has done literary work outside of daily journalism.

ALBERT WILLIAMS, JR., (*Some Facts about the Silver Industry*)=Born in San Francisco in 1852; graduated from Phillips Academy, Andover, 1868; from Princeton, 1872, of which institution he is Fellow in experimental science; took a special course at the Columbia College School of Mines, 1872-73; has had wide practice as a mining and metallurgical expert in various districts of this country and Mexico, and is now stationed at Denver; formerly chief of the division of mining statistics and technology of the United States Geological Survey, organizing that service and publishing the annual reports from 1882 to 1885. As director he organized the Michigan Mining School at Houghton, 1886 87. Mr. WILLIAMS has contributed largely to the scientific and technical press during twenty years.

ROBERT B. DASHIELL, Ensign U. S. N. (*Development of the Nickel-Steel Armor-Plate*) =Graduated from the United States Naval Academy at Annapolis, in 1881. When not at sea he has been engaged on ordnance duty. Mr. DASHIELL designed and built the works at the Naval Proving-ground at Indian Head, Md., and has conducted all the tests of guns and plates at that station. Mr. DASHIEL is the inventor of the rapid firing cannon bearing his name which has been adopted for the Naval service; and is now stationed at Cramp's shipyard, Philadelphia, for the purpose of installing the battery on the armored cruiser *New York*.

GEORGE E. ROBERTS (*The Real Condition of the Farmer*)=Born in Iowa, August 19, 1857, and spent his boyhood on a farm; at the age of sixteen entered the office of the Fort Dodge *Messenger*, now a prosperous daily and weekly journal of which he is the owner and editor; has served three terms, aggregating six years, as Public Printer of Iowa, by election by the Legislature; is the owner of a farm, the management of which he directs. Throughout his life his interests have been so closely identified with those of a great agricultural population as to have fitted him particularly to treat of modern farm conditions.

HORACE FIELD PARSHALL (*Electricity and Electric Generators*)=Born Milford, N. Y.; educated at Hartwick (N. Y.) Theological Seminary, Cornell University, and Lehigh University; designing engineer for the Sprague Electric Railway and Motor Co., and later for the Wenstrom Consolidated Dynamo and Motor Co.; electrical engineer of the Edison Schenectady works; at present engineer in charge of the calculating department of the General Electric Co., at Lynn, Mass.

H. C. PEARSON (*The Growth of Commerce on the Great Lakes*)=A member of the Michigan Association of Surveyors and Engineers; trained in early life as a shipbuilder, and at present practising his profession of civil engineer, with which he joins the regulation of ship's compasses; is the author of a treatise on navigation specially adapted to the navigation of the western lakes, a subject with which he is particularly familiar.

EMIL SCHALK (*A Scientific Analysis of Money*)=A graduate of the Ecole Centrale des Arts et Manufactures of Paris, the greatest engineering school existing, and to which France is indebted for the high state of her industries; has published "The Art of War" and "The Campaign of 1862-63"; member of the Consolidated Stock and Petroleum Exchange of New York.

JAMES L. COWLES (*Distance not a Factor in the Cost of Railway Traffic*)=Studied law and was admitted to the Connecticut bar; spent the years 1880-1883 in Europe; 1883-88 engaged chiefly as a student and writer on economic questions; member of the Cobden Club, of the Reform Club (New York), and a vice-president of the New England Tariff Reform League; a frequent contributor to the periodical press, especially upon railway topics, with which he became practically familiar while interested in manufacturing.

WILLIAM J. FRYER (*The Need of a Uniform Building Law*)=Chairman New York State Building Law Commission; member of the Commission to prepare new building laws for Brooklyn; member of the board of examiners in the Department of Buildings, New York; prime mover and active worker in securing the several revisions of the New York Building law since 1879: author of the standard edition of the New York Building Law; well-known authority on iron construction and building law; refused the office of Supervising Architect in Mr. Cleveland's first administration; consulting architect and engineer.

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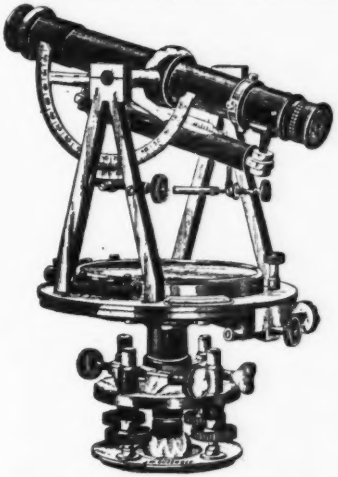

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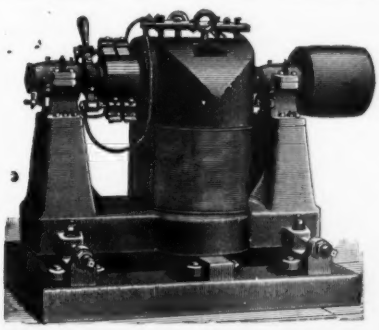

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J. Jones & Son, 39 Vesey St., N. Y.
C. S. Knowles, Boston, Mass.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

Electrical Instruments.

Card Electric Motor & Dynamo Co., Cincinnati, O.
Colburn Electric Mfg. Co., Fitchburg, Mass
J. Jones & Son, 39 Vesey St., N. Y.
Standard Thermometer Co., Peabody, Mass.
United Electric Improvement Co., Philadelphia, Pa.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.
Weston Electrical Instrument Co., Newark, N. J.

Electrical Rubber Goods.

Home Rubber Co., Trenton, N. J.
C. S. Knowles, Boston, Mass.
Newton Rubber Co., Boston, Mass.
Spinney Virtue & Co., Lynn, Mass.

Elevators, Steam, Hydraulic, Electric.

Graves Elevator Co., Rochester, N. Y.
Howard Foundry and Machine Works, Phila.
Morse, Williams & Co., Philadelphia, Pa.
Otis Brothers & Co., 38 Park Row, New York.
Springfield Foundry Co., Springfield, Mass.
Thos. G. Laney, Lima, Ohio.
Lane & Bodley Co., Cincinnati, Ohio.

Emery Wheels.

Pennsylvania Machine Co., Philadelphia, Pa.

Emery Wheel Machinery.

Pennsylvania Machine Co., Philadelphia, Pa.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.

Engineering Instruments.

Theo. Alteneder & Sons, Brooklyn, N. Y.
Brandis Sons Co., Brooklyn, N. Y.
Keuffel & Esser Co., 127 Fulton St., N. Y.
F. Weber & Co., Philadelphia, Pa.
Queen & Co. Philadelphia, Pa.

Engines, Blowing.

Edw. P. Allis Co., Milwaukee, Wis.
Cooke & Co., 163 Washington St., N. Y.
B. F. Sturtevant Co., Boston, Mass.
Southwark Foundry and Machine Co., Phila., Pa.
Walker Manufacturing Co., Cleveland, Ohio.

Engines, Gas, Gasoline, and Petroleum.

Otto Gas Engine Works, Philadelphia, Pa.
Pennsylvania Machine Co., Philadelphia, Pa.

Engines, Marine.

Rice & Whitacre Mfg. Co., Chicago, Ill.
Shipman Engine Co., Boston, Mass.

Engines, Portable.

Griffith & Wedge Co., Zanesville, Ohio.

Engines, Stationary.

American Well Works, Aurora, Ill.
Edw. P. Allis Co., Milwaukee, Wis.
Beckett Foundry and Machine Co., Arlington, N. J.
Buckeye Engine Co., Salem, Ohio.
M. C. Bullock Mfg. Co., Chicago, Ill.
Thomas Carlin's Sons, Allegheny, Penna.
Cooke & Co., 163 Washington St., N. Y.
Erie Engine Works, Erie, Penna.
Fairbanks, Morse & Co., Chicago, Ill.
Fitchburg Steam Engine Co., Fitchburg, Mass.
Frick Company, Waynesboro, Pa.
Hooven, Owens & Rentschler Co., Hamilton, Ohio.
Jarvis Engineering Co., Boston, Mass.
Lane & Bodley Co., Cincinnati, Ohio.
John T. Noye Manufacturing Co., Buffalo, N. Y.
Oil Well Supply Co., Pittsburgh, Pa.
Pennsylvania Machine Co., Philadelphia, Pa.
Rice & Whitacre Mfg. Co., Chicago, Ill.
Shipman Engine Co., Boston, Mass.
Southwark Foundry and Machine Co., Phila., Pa.
Stearns Manufacturing Co., Erie, Pa.
Webster, Camp & Lane Machine Co., Akron, O.
Chas. P. Willard & Co., Chicago, Ill.
Robert Wetherill & Co., Chester, Penn.

Excavators.

Bucyrus Steam Shovel and Dredge Co., S. Milwaukee, Wis.
Jeffrey Mfg. Co., Columbus, Ohio.
Marion Steam Shovel Co., Marion, Ohio.
Osgood Dredge Co., Albany, N. Y.
John Souther & Co., Boston, Mass.

Fans, Ventilating.

M. C. Bullock Mfg. Co., Chicago, Ill.

Feed-Water Heaters.

Wm. Baragwanath & Son, Chicago.
Edw. P. Allis Co., Milwaukee, Wis.
Fairbanks, Morse & Co., Chicago, Ill.
Harrison Safety Boiler Wks, G'town Junction, Phila.
Jarvis Engineering Co., Boston, Mass.
National Pipe Bending Co., New Haven, Conn.
Pennsylvania Machine Co., Philadelphia, Pa.
Robt. Wetherill & Co., Chester, Pa.
Rice & Whitacre Mfg. Co., Chicago, Ill.
Whitlock Coil Pipe Co., Elmwood, Conn.
Goubert Mfg. Co., 32 Cortlandt St., N. Y.

Fertilizer Machinery.

Bradley Fertilizer Co., Boston, Mass.
Jeffrey Mfg. Co., Columbus, Ohio.
Walburn-Swenson Co., Chicago, Ill.

Filter Presses.

Walburn-Swenson Co., Chicago, Ill.

Fire Arms.

J. Stevens Arms & Tool Co., Chicopee Falls, Mass.

Fireproof Building Material.

Canton Steel Roofing Co., Canton, Ohio.
Central Expanded Metal Co., Pittsburgh, Pa.
Berlin Iron Bridge Co., East Berlin, Conn.
Fred F. Bischoff & Co., Chicago, Ill.
Edward Darby & Sons, Philadelphia, Pa.
Kinnear & Gager Co., Columbus, Ohio.
Niles Iron & Steel Roofing Co., Niles, Ohio.
Pennsylvania Steel Co., Steelton, Pa.
Pioneer Fireproof Construction Co., Chicago, Ill.

Flexible Shafts.

Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.

Flouring Mill Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
Dayton Globe Iron Works Co., Dayton, Ohio.

Flumes.

Rodney Hunt Machine, Co., Orange, Mass.

Fly Wheels.

Edw. P. Allis Co., Milwaukee, Wis.
Lane & Bodley Co., Cincinnati, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Forges.

Buffalo Forge Co., Buffalo, N. Y.
Cooke & Co., 163 Washington St., N. Y.
Pennsylvania Machine Co., Philadelphia, Pa.
B. F. Sturtevant Co., Boston, Mass.

Foundry Equipment.

Detroit Foundry Equipment Co., Detroit, Mich.
Walburn-Swenson Co., Chicago, Ill.

Forgings.

Billings & Spencer Co., Hartford, Conn.
Crescent Steel Co., Pittsburgh, Pa.

Furnace Builders.

Griffith & Wedge Co., Zanesville, Ohio.
Julian Kennedy, Pittsburgh, Pa.
Walburn-Swenson Co., Chicago, Ill.

Furniture and Chair Machinery.

Fox Machine Co., Grand Rapids, Mich.
C. B. Rogers & Co., Norwich, Conn.
John A. White Co., Dover, N. H.

Gas Works Machinery.

Continental Iron Works, Brooklyn, N. Y.

Gaskets, Copper.

U. S. Mineral Wool Co., 2 Cortlandt St., N. Y.

Gate Valves.

Chapman Valve Mfg. Co., Indian Orchard, Mass.
Continental Iron Works, Brooklyn, N. Y.
Pancoast & Rogers, 22 Platt St., New York.

Gauges, Steam.

Crosby Steam Gage and Valve Co., Boston, Mass.
Reliance Gauge Co., Cleveland, O.
Standard Thermometer Co., Peabody, Mass.

Gear Cutters.

E. Horton & Son Co., Windsor Locks, Conn.
Pennsylvania Machine Co., Philadelphia, Pa.
Standard Tool Co., Cleveland, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Gearing.

Edw. P. Allis Co., Milwaukee, Wis.
Dayton Globe Iron Works Co., Dayton, Ohio.
Griffith & Wedge Co., Zanesville, Ohio.
Lane & Bodley Co., Cincinnati, Ohio.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Walker Manufacturing Co., Cleveland, Ohio.

Girders.

Berlin Iron Bridge Co., East Berlin, Conn.
Pennsylvania Steel Co., Steelton, Pa.
Wrought Iron Bridge Co., Canton, Ohio.

Grain Elevator Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
Jeffrey Mfg. Co., Columbus, Ohio.
Link Belt Engineering Co., Phila., Pa.
Walker Manufacturing Co., Cleveland, Ohio.

Grates.

Samuel H. French & Co., Philadelphia, Pa.

Grinding and Polishing Machinery.

Cincinnati Milling Machine Co., Cincinnati, Ohio.
Cleveland Twist Drill Co., Cleveland, Ohio.
Diamond Machine Co., Providence, R. I.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, Ohio.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.

Grips, Cable Railways.

Walker Manufacturing Co., Cleveland, Ohio.
Robt. Wetherill & Co., Chester, Pa.

Hangers.

SEE PULLEYS, ETC.

Hardware Manufacturers.

J. Stevens Arms & Tool Co., Chicopee Falls, Mass.
Yale & Towne Mfg. Co., Stamford, Conn.

Heating and Ventilating Apparatus.

Buffalo Forge Co., Buffalo, N. Y.
B. F. Sturtevant Co., Boston, Mass.
Cooke & Co., 163 Washington St., N. Y.

Heaters, Steam and Hot Water.

American Boiler Co., Boston, New York, Chicago.
Boynton Furnace Co., 207 Water St., New York.
W. C. Mowry, Norwich, Conn.
New York Central Iron Works Co., Geneva, N. Y.
J. F. Pease Furnace Co., Syracuse, N. Y.
H. B. Smith Co., 137 Center St., N. Y.
United States Heater Co., Detroit, Mich.

Hoisting Engines and Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
Beckett Foundry and Machine Co., Arlington, N. J.
M. C. Bullock Mfg. Co., Chicago, Ill.
John F. Byers Machine Co., Ravenna, Ohio.
Thomas Carlin's Sons, Allegheny, Penna.
Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
Contractors' Plant Mfg. Co., Buffalo, N. Y
Copeland & Bacon, 85 Liberty St., N. Y.
Fairbanks, Morse & Co., Chicago, Ill.
Fulton Iron and Engine Works, Detroit, Mich.
Griffith & Wedge Co., Zanesville, Ohio.
Edwin Harrington, Son & Co., Philadelphia, Pa.
C. W. Hunt Co., 45 Broadway, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
Maris & Beekley, Philadelphia, Pa.
Moore Mfg. & Foundry Co., Milwaukee, Wis.
J. S. Mundy, Newark, N. J.
Rice & Whitacre Mfg. Co., Chicago, Ill.
Webster, Camp & Lane Machine Co., Akron, O.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.
Walker Manufacturing Co., Cleveland, Ohio.
Yale & Towne Mfg. Co., Stamford, Conn.

Hollow Bricks.

Lorillard Brick Works Co., 92 Liberty St., N. Y.
Pioneer Fireproof Construction Co., Chicago, Ill.

Hose, Steam and Fire.

Boston Woven Hose & Rubber Co., Boston, Mass.
Crosby Steam Gage and Valve Co., Boston, Mass.
Home Rubber Co., Trenton, N. J.
Peerless Rubber Mfg. Co., 15 Warren St., N. Y.

Hydraulic Cement.

Lawrence Cement Co., 67 William St., N. Y.

Hydraulic Machinery.

Pelton Water Wheel Co., San Francisco and N. Y.
Watson & Stillman, 204 E. 43d St., N. Y.

Ice-Making Machinery.

Frick Company, Waynesboro, Pa.

Indicators, Steam-Engine

Crosby Steam Gage and Valve Co., Boston, Mass.

Injectors.

Wm. Sellers & Co., Philadelphia, Pa.
Penberthy Injector Co., Detroit, Mich.
Sherwood Mfg. Co., Buffalo, N. Y.

Industrial Railways.

C. W. Hunt Co., 45 Broadway, N. Y.

Insulating Compounds.

Standard Paint Co., 2 Liberty St., N. Y.

Insulating Papers.

Standard Paint Co., 2 Liberty St., N. Y.

Insulated Wire

Eastern Electric Cable Co., Boston, Mass.
C. S. Knowles, Boston, Mass.
Merchant & Co., Philadelphia, Pa.
The Okonite Co., Limited, 13 Park Row, N. Y.

Iron Working Machinery.

W. F. & J. Barnes Co., Rockford, Ill.
John Becker Mfg. Co., Fitchburg, Mass.
Betts Machine Co., Wilmington, Del.
Billings & Spencer Co., Hartford, Conn.
Brainard Milling Machine Co., Hyde Park, Mass.
Cushman Chuck Co., Hartford, Conn.
Dwight Slate Machine Co., Hartford, Conn.
Fox Machine Co., Grand Rapids, Mich.
Edwin Harrington, Son & Co., Philadelphia, Pa.
Hendey Machine Co., Torrington, Conn.
Hill, Clark & Co., Chicago, Ill.
E. Horton & Son Co., Windsor Locks, Conn.
Jones & Lamson Mch. Co., Springfield, Vt.
Long & Allstatter Co., Hamilton, Ohio.
Niles Tool Works, Hamilton, Ohio.
Pennsylvania Machine Co., Philadelphia, Pa.
Wm. Sellers & Co., Philadelphia, Pa.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
Walker Manufacturing Co., Cleveland, Ohio.

Joists, Iron and Steel.

Berlin Iron Bridge Co., East Berlin, Conn.

Ladles.

Detroit Foundry Equipment Co., Detroit, Mich.

Lathes.

W. F. & J. Barnes Co., Rockford, Ill.
Betts Machine Co., Wilmington, Del.
Bridgeport Machine Tool Works, Bridgeport, Conn.
Edwin Harrington, Son & Co., Philadelphia, Pa.
Hendey Machine Co., Torrington, Conn.
Hill, Clark & Co., Chicago, Ill.
Jones & Lamson Mch. Co., Springfield, Vt.
Niles Tool Works, Hamilton, Ohio.
Pennsylvania Machine Co., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
Sebastian Lathe Co., Cincinnati, Ohio.
Wm. Sellers & Co., Philadelphia, Pa.

Lamps.

Pittsburgh Brass Co., Pittsburgh, Pa.

Lamps, Electric.

Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

Launches, Steam.

Chas. P. Willard & Co., Chicago, Ill.

Locomotives.

Baldwin Locomotive Works, Philadelphia, Pa.

Locomotive Brakes.

New York Air Brake Co., 115 Broadway, N. Y.
Westinghouse Air Brake Co., Pittsburgh, Pa.

Lubricants.

Jos. Dixon Crucible Co., Jersey City, N. J.

Lubricators.

Sherwood Mfg. Co., Buffalo, N. Y.

Machine Screws, etc.

Worcester Machine Screw Co., Worcester, Mass.

Machine Tools and Supplies.

W. F. & J. Barnes Co., Rockford, Ill.
John Becker Mfg. Co., Fitchburg, Mass.
Betts Machine Co., Wilmington, Del.
Billings & Spencer Co., Hartford, Conn.
Boynton & Plummer, Worcester, Mass.
Brainard Milling Machine Co., Hyde Park, Mass.
Bridgeport Machine Tool Works, Bridgeport, Conn.
Cincinnati Milling Machine Co., Cincinnati, Ohio.
Cleveland Twist Drill Co., Cleveland, Ohio.
Cooke & Co., 163 Washington St., N. Y.
Cushman Chuck Co., Hartford, Conn.
Dwight Slate Machine Co., Hartford, Conn.
Fox Machine Co., Grand Rapids, Mich.
Edwin Harrington, Son & Co., Philadelphia, Pa.
E. Horton & Son Co., Windsor Locks, Conn.
Hendey Machine Co., Torrington, Conn.
Hill, Clarke & Co., Chicago, Ill.
Jones & Lamson Mch. Co., Springfield, Vt.
Long & Allstatter Co., Hamilton, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
National Machinery Co., Tiffin, Ohio.
Niles Tool Works, Hamilton, Ohio.
Pennsylvania Machine Co., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
C. B. Rogers & Co., Norwich, Conn.
Wm. Sellers & Co., Philadelphia, Pa.
Standard Tool Co., Cleveland, Ohio.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Sebastian Lathe Co., Cincinnati, Ohio.
J. Stevens Arms & Tool Co., Chicopee Falls, Mass.
Walker Manufacturing Co., Cleveland, Ohio.
John A. White Co., Dover, N. H.

Mantels.

Samuel H. French & Co., Philadelphia, Pa.

Mathematical Instruments.

Theo. Alteneder & Sons, Philadelphia, Pa.
Keuffel & Esser Co., 127 Fulton St., N. Y.
F. Weber & Co., Philadelphia, Pa.
Queen & Co., Philadelphia, Pa.

Merchant Steel.

Chester Steel Castings Co., Phila., Pa.
Crescent Steel Co., Pittsburgh, Pa.
Wm. Jessop & Sons, Limited, 91 John St., N. Y.

Metal Separator.

Ezra Sawyer, Worcester, Mass.

Meters, Water.

Deane Steam Pump Co., Holyoke, Mass.
Henry R. Worthington, 86-88 Liberty St., N. Y.

Milling Machines.

John Becker Mfg. Co., Fitchburg, Mass.
Brainard Milling Machine Co., Hyde Park, Mass.
Cincinnati Milling Machine Co., Cincinnati, Ohio.
Fox Machine Co., Grand Rapids, Mich.

Mining Screens.

Beckett Foundry and Machine Co., Arlington, N. J.
Copeland & Bacon, 85 Liberty St., N. Y.
Harrington & King Perf. Co., Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.
Ludlow-Saylor Wire Co., St. Louis, Mo.

Mining Machinery.

American Ore Machinery Co., 1 Broadway, N. Y.
Beckett Foundry and Machine Co., Arlington, N. J.
Bradley Fertilizer Co., Boston, Mass.
M. C. Bullock Mfg. Co., Chicago, Ill.
Chrome Steel Works, Brooklyn, N. Y.
A. S. Cameron Steam Pump Works, E. 23d St., N. Y.
Copeland & Bacon, 85 Liberty St., N. Y.
Frisbee-Lucop Mill Co., 145 Broadway, N. Y.
Gates Iron Works, Chicago, Ill.
Griffith & Wedge Co., Zanesville, Ohio.
Harrington & King, Perf. Co., Chicago, Ill.
Ingersoll-Sergeant Drill Co., Cortlandt St., N. Y.
Jeffery Mfg. Co., Columbus, Ohio.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
J. S. Mundy, Newark, N. J.
Niagara Steam Pump Works, 34 Dey St., N. Y.
Rand Drill Co., 23 Park Place, N. Y.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.
Walburn-Swenson Co., Chicago, Ill.
Waldo & Stout, Bridgeport, Conn.
Webster, Camp & Lane Machine Co., Akron, O.

Motors, Electric.

Card Electric Motor & Dynamo Co., Cincinnati, O.
Jeffrey Mfg. Co., Columbus, Ohio.
Standard Thermometer Co., Peabody, Mass.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

Motors, Water.

Pelton Water Wheel Co., San Francisco and N. Y.
Henry R. Worthington, 86-88 Liberty St., N. Y.

Nut Locks.

Eureka Nut Lock Co., Pittsburgh, Pa.

Oil Cups, Glass.
Sherwood Mfg. Co., Buffalo, N. Y.

Ornaments, Stamped Sheet Metal.
Fred F. Bischoff & Co., Chicago, Ill.

Packing
Boston Woven Hose & Rubber Co., Boston, Mass.
Home Rubber Co., Trenton, N. J.
Garlock Packing Co., Palmyra, N. Y.
Sherwood Mfg. Co., Buffalo, N. Y.
Peerless Rubber Mfg. Co., 15 Warren St., N. Y.
Watson & Stillman, 204 E. 43d St., N. Y.

Packing House Machinery.
Walburn-Swenson Co., Chicago, Ill.

Paints.
Canton Steel Roofing Co., Canton, Ohio.
Joseph Dixon Crucible Co., Jersey City, N. J.
Samuel H. French & Co., Philadelphia, Pa.
Harrison Bros. & Co., Philadelphia, Pa.
Standard Paint Co., 2 Liberty St., N. Y.

Paper Mill Machinery.
Dayton Globe Iron Works, Dayton, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Lane & Bodley Co., Cincinnati, Ohio.
Moore & White Co., Philadelphia, Pa.
Walker Manufacturing Co., Cleveland, Ohio
Robt. Wetherill & Co., Chester, Pa.

Patent Attorneys.
Du Bois & Du Bois, Washington, D. C.
Munn & Co., 361 Broadway, N. Y.
Wm. A. Rosenbaum, 177 Times B'ld'g, New York.
John A. Wiedersheim, Philadelphia, Pa.

Penstocks.
Rodney Hunt Machine Co., Orange, Mass.

Perforated Metal.
Harrington & King, Perf. Co., Chicago, Ill.
Merchant & Co., Philadelphia, Pa.

Photographic Supplies.
Rochester Optical Co., Rochester, N. Y.

Pile Drivers.
Bucyrus Steam Shovel & Dredge Co., S Milwaukee, Wis.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.

Pile Hammers.
R. J. & A. B. Cram, Detroit, Mich.

Pipe Casings, etc.
Michigan Pipe Co., Bay City, Mich.
Oil Well Supply Co., Pittsbrugh, Pa.
Pancoast & Rogers, 22 Platt St., New York.
A. Wyckoff & Son, Elmira, N. Y.

Pipe, Cast Iron.
Addyston Pipe & Steel Co., Cincinnati, Ohio.
Michigan Pipe Co., Bay City, Mich.
Ohio Pipe Co., Columbus, Ohio.
Pancoast & Rogers, 22 Platt St., New York.
Walker Manufacturing Co., Cleveland, Ohio.

Pipe, Coils and Bends.
National Pipe Bending Co., New Haven, Conn.

Pipe Cutting and Threading Machines.
Bignall & Keeler Mfg. Co., St. Louis, Mo.
Pennsylvania Machine Co., Philadelphia, Pa.

Pipe-Spiral Riveted.
Abendroth & Root Mfg Co., 28 Cliff St., N. Y.
Merchant & Co., Philadelphia, Pa.
Michigan Pipe Co., Bay City, Mich.

Pipe, Wrought Iron, Line and Drive.
Michigan Pipe Co., Bay City, Mich.
Oil Well Supply Co., Pittsburgh, Pa.
Pancoast & Rogers, 22 Platt St., New York.

Planing Mill Machinery.
Fox Machine Co., Grand Rapids, Mich.
Pennsylvania Machine Co., Philadelphia, Pa.
C. B. Rogers & Co., Norwich, Conn.
John A. White Co., Dover, N. H.

Plumbing and Sanitary Goods.
Standard Mfg. Co., Pittsburgh, Pa.

Portable Railways.
C. W. Hunt Co., 45 Broadway, N. Y.

Power Punches and Shears.
Long & Allstatter Co., Hamilton, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Presses, Baling.
Boomer & Boschert Press Co., Syracuse, N. Y.
Watson & Stillman, 204 E. 43d St., N. Y.

Presses, Hydraulic.
Boomer & Boschert Press Co., Syracuse, N. Y.
Niles Tool Works, Hamilton, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
Watson & Stillman, 204 E. 43d St., N. Y.

Pressure Regulators.
Locke Regulator Co., Salem, Mass.
Mason Regulator Co., Boston, Mass.
Rodney Hunt Machine Co., Orange, Mass.
Standard Thermometer Co., Peabody, Mass.

Prospecting Drills.
American Well Works, Aurora, Ill.
M. C. Bullock Mfg. Co., Chicago, Ill.
Stearns Bros., 46 Ann St., New York.
Sullivan Machinery Co., Chicago, Ill.

Pulley Lathes.
W. F. & J. Barnes Co., Rockford, Ill.

Pulleys, Shafting and Hangers.
Edw. P. Allis Co., Milwaukee, Wis.
Cooke & Co., 163 Washington St., N. Y.
Dayton Globe Iron Works, Dayton, Ohio.
Griffith & Wedge Co., Zanesville, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Lane & Bodley Co., Cincinnati, Ohio.
Moore & White Co., Philadelphia, Pa.
Pennsylvania Machine Co., Philadelphia, Pa.
Wm. Sellers & Co., Philadelphia, Pa.
Robt. Wetherill & Co., Chester, Penn.
Volney W. Mason & Co., Providence, R. I.
Walker Manufacturing Co., Cleveland, Ohio.

Pulverizers.
American Ore Machinery Co., 1 Broadway, N. Y.
Bradley Fertilizer Co., Boston, Mass.
F. D. Cummer & Son Co., Cleveland, Ohio.
Frisbee-Lucop Mill Co., 145 Broadway, N. Y.

Pumps and Pumping Machinery.
American Well Works, Aurora, Ill.
Edw. P. Allis Co., Milwaukee, Wis.
A. S. Cameron Steam Pump Works, E. 23d St., N. Y.
Cooke & Co., 163 Washington St., N. Y.
M. T. Davidson, Brooklyn, N. Y.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Thos. G. Laney, Lima, Ohio.
Deane Steam Pump Co., Holyoke, Mass.
Fairbanks, Morse & Co., Chicago, Ill.
Guild & Garrison, Brooklyn, N. Y.
Holly Mfg. Co., Lockport, N. Y.
Knowles Steam Pump Works, New York.
Niagara Steam Pump Works, 34 Dey St., N. Y.
Pulsometer Steam Pump Co., 120 Liberty St., N. Y.
Southwark Foundry & Machine Co., Phila., Pa.
Stillwell-Bierce & Smith-Vaile Co., Dayton, Ohio.
Watson & Stillman, 204 E. 43d St., N. Y.
Walker Manufacturing Co., Cleveland, Ohio.
Webster, Camp & Lane Machine Co., Akron, O.
Wheeler Condenser & Eng. Co., 92 Liberty St., N. Y.
Henry R. Worthington, 86-88 Liberty St., N. Y.

Pump Governors.
Locke Regulator Co., Salem, Mass.
Mason Regulator Co., Boston, Mass.

Punching and Shearing Presses.
Long & Allstatter Co., Hamilton, Ohio.
Niagara Stamping and Tool Co., Buffalo, N. Y.
Walker Manufacturing Co., Cleveland, Ohio.
Watson & Stillman, 204 E. 43d St., N. Y.

Quarrying Machinery.
M. C. Bullock Mfg. Co., Chicago, Ill.
A. S. Cameron Steam Pump Works, E. 23d St., N. Y.
Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
Ingersoll-Sergeant Drill Co., Cortlandt St., N. Y
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
J. S. Mundy, Newark, N. J.
Rand Drill Co., 23 Park Place, N. Y.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.

Radiators.
American Radiator Co., Chicago, Ill.
H. B. Smith Co., 137 Center St., N. Y.

Railway Car Brakes.
New York Air Brake Co., 115 Broadway, N. Y.
Westinghouse Air Brake Co., Pittsburgh, Pa.

Railroad Ditcher.
Bucyrus Steam Shovel & Dredge Co., S. Milwaukee, Wis
Jeffrey Mfg. Co., Cleveland, O.
Marion Steam Shovel Co., Marion, Ohio.
Osgood Dredge Co , Albany, N. Y.
John Souther & Co., Boston., Mass.

Railway Feed Wires.
The Okonite Co., Limited, 13 Park Row, N. Y.

Railway Shop Machinery.
John Becker Mfg. Co., Fitchburg, Mass.
Billings & Spencer Co., Hartford, Conn.
Boynton & Plummer, Worcester, Mass.
Bridgeport Machine Tool Works, Bridgeport, Conn.
Cushman Chuck Co., Hartford, Conn.
Fox Machine Co., Grand Rapids, Mich.
Edwin Harrington, Son & Co., Philadelphia, Pa.
Hendey Machine Co., Torrington, Conn.
Hill, Clark & Co., Chicago, Ill.
E. Horton & Son Co., Windsor Locks, Conn.
Lane & Bodley Co., Cincinnati, Ohio.
Long & Allstatter Co., Cincinnati, Ohio.
Maris & Beekley, Philadelphia, Pa.
National Machinery Co., Tiffin, Ohio.
Niles Tool Works, Hamilton, Ohio.
Pennsylvania Machine Co., Philadelphia, Pa.
C. B. Rogers & Co., Norwich, Conn.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Walker Manufacturing Co., Cleveland, Ohio.
Watson & Stillman, 204 E. 43d St., N. Y.
John A. White Co., Dover, N. H.

Railway Specialities.
Eureka Nut Lock Co., Pittsburgh, Pa.
The Q. & C. Co., Chicago, Ill.

Railways, Portable.
C. W. Hunt Co., 45 Broadway, N. Y.

Railway Supplies.
Eureka Nut Lock Co., Pittsburgh, Pa.
Pennsylvania Steel Co., Steelton, Pa.
Sargent Company, Chicago, Ill.

Ratchet Drills.
Pratt & Whitney Co., Hartford, Conn.

Reducing Valves.
Locke Regulator Co., Salem, Mass.
Mason Regulator Co., Boston, Mass.

Refrigerating Machinery.
Frick Company, Waynesboro, Pa.

Road-Making Machinery.
Addyston Pipe & Steel Co., Cincinnati, Ohio.
Bucyrus Steam Shovel & Dredge Co., S. Milwaukee, Wis.
O. S. Kelly Co., Springfield, Ohio.
Marion Steam Shovel Co., Marion, Ohio.
John Souther & Co., Boston. Mass.

Road Rollers, Steam.
Harrisburgh F'd'y & Machine W'ks, Harrisburg, Pa.
O. S. Kelly Co., Springfield, Ohio.

Rock Breakers.
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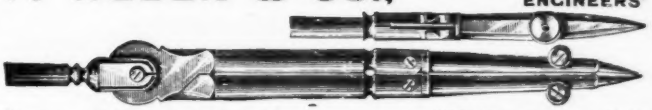

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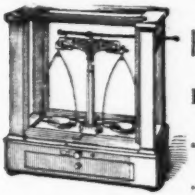

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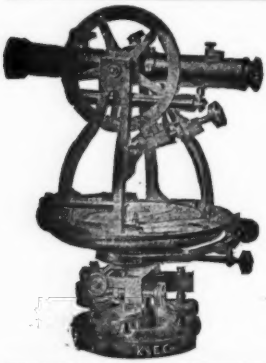

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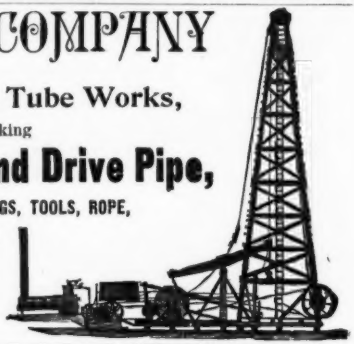

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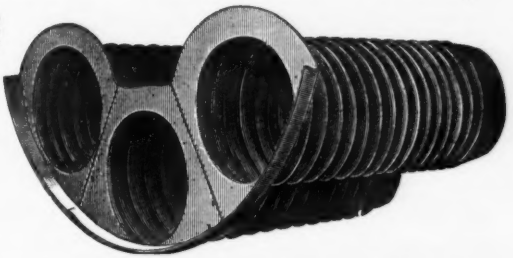

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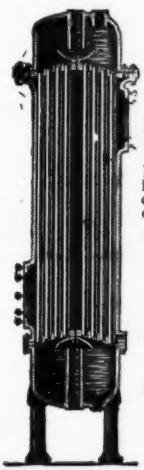

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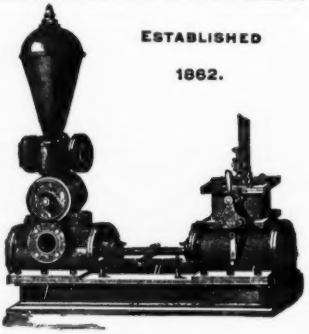

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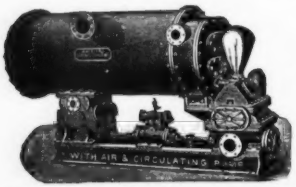

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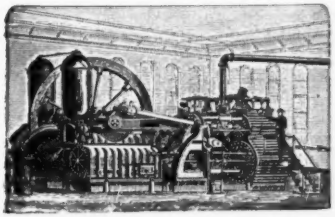

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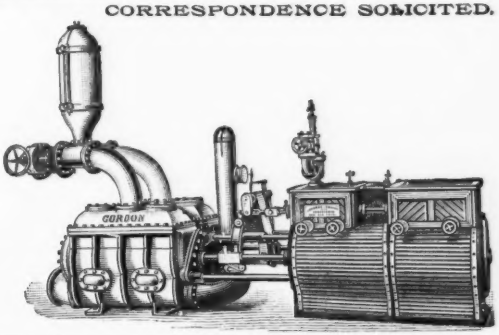

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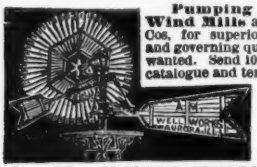

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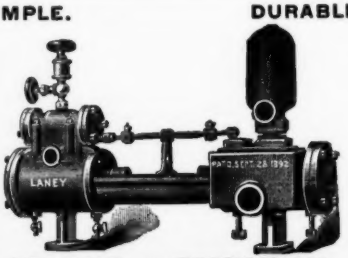

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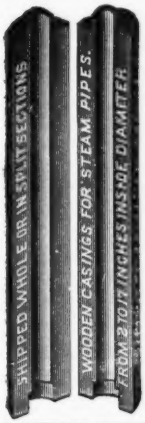

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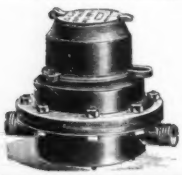

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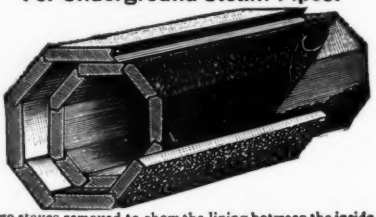

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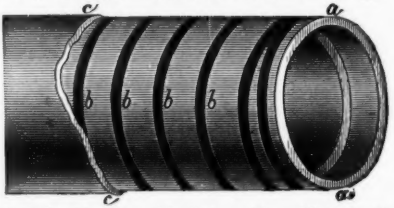

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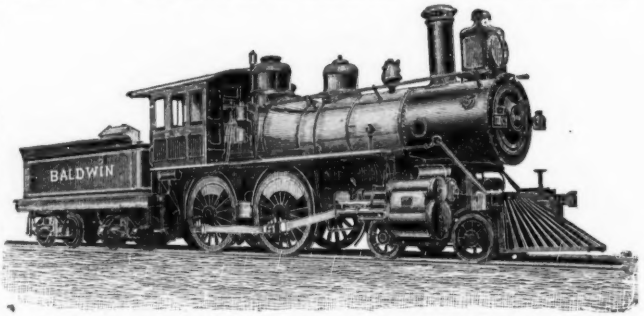

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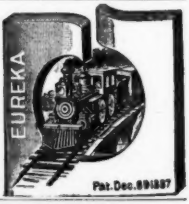

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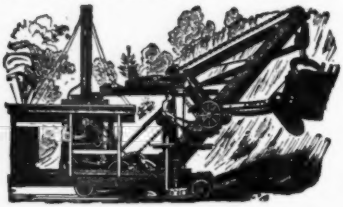

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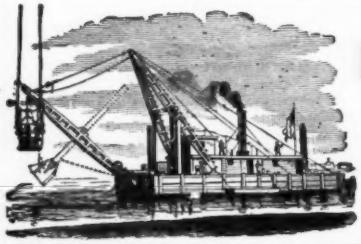

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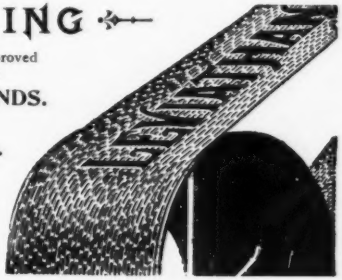

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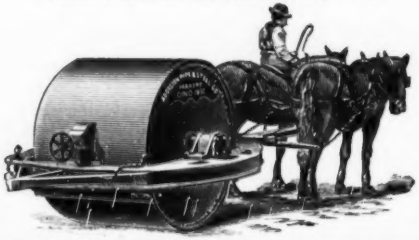

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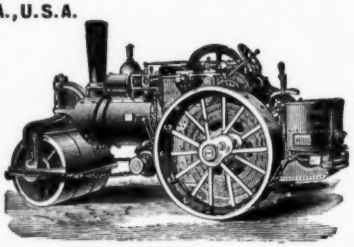

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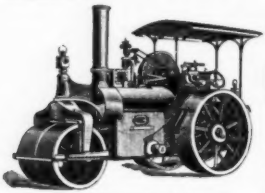

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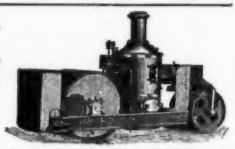

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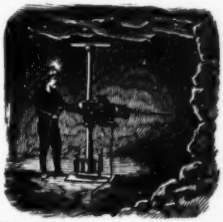

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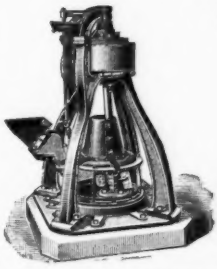

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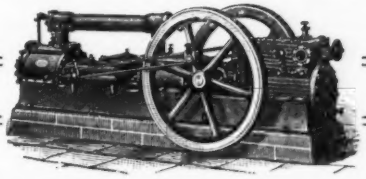

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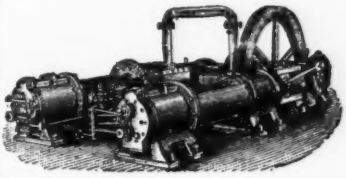

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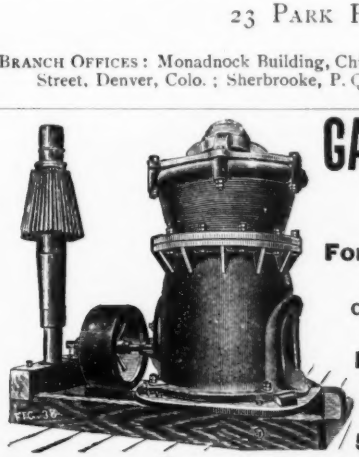

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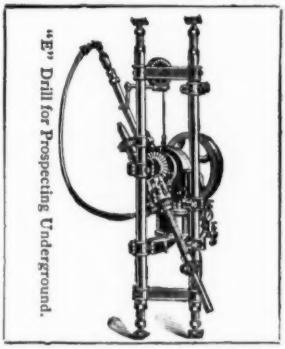

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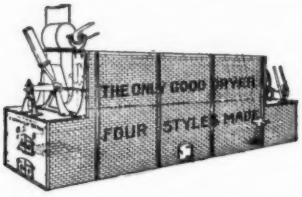

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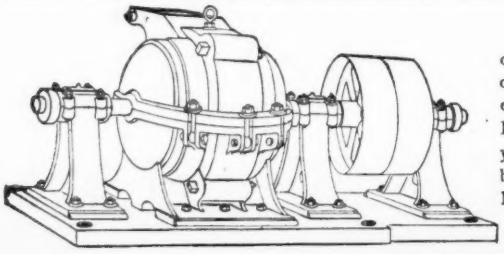

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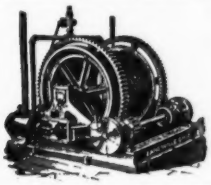

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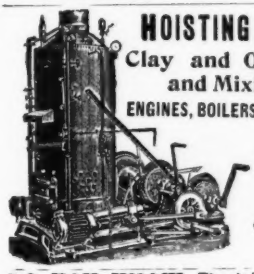

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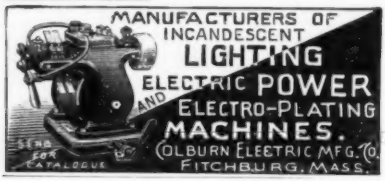

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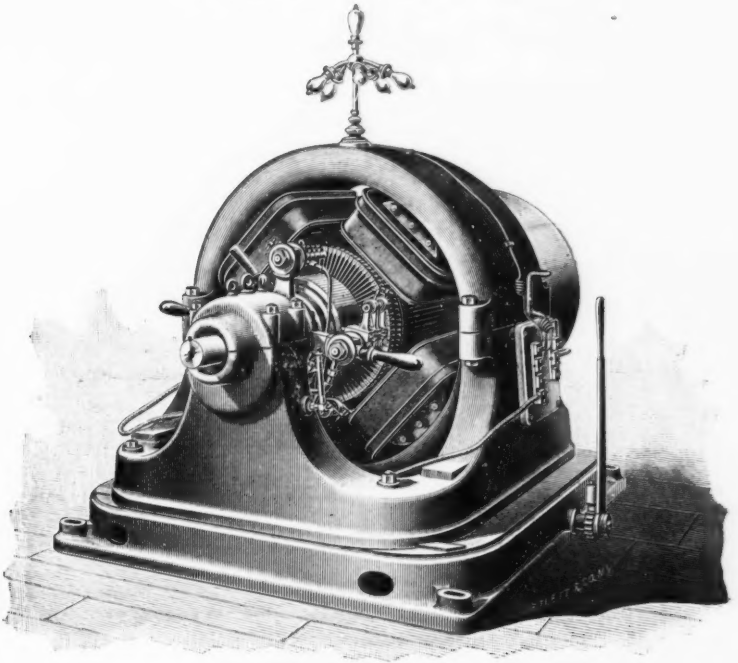

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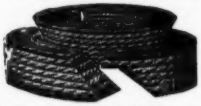

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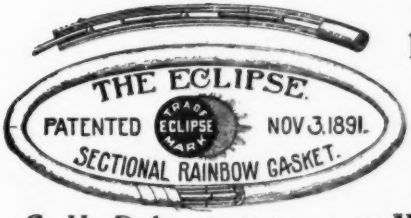

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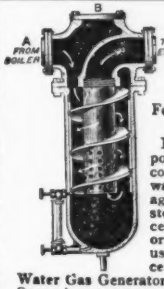

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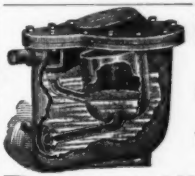

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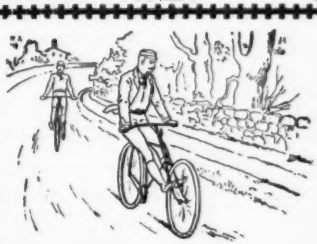

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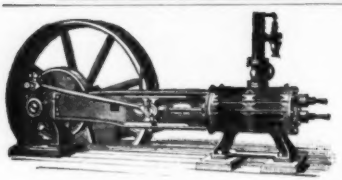

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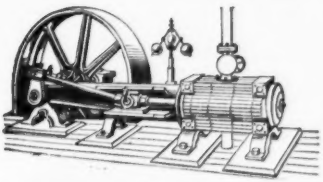

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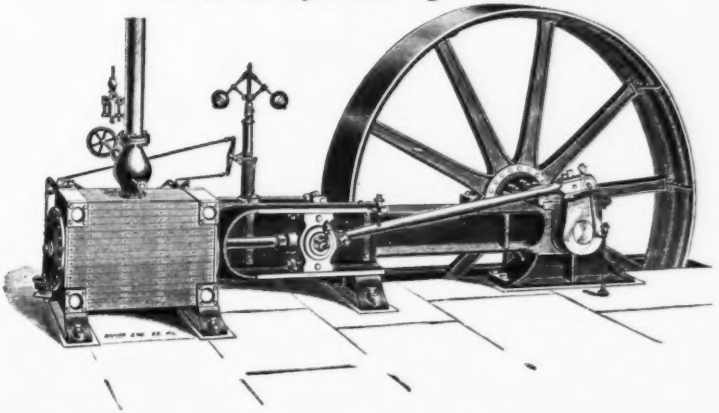

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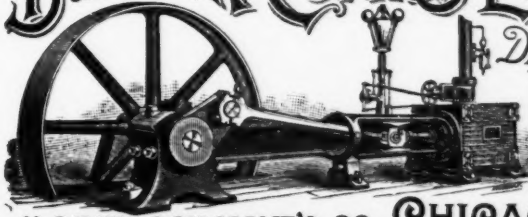

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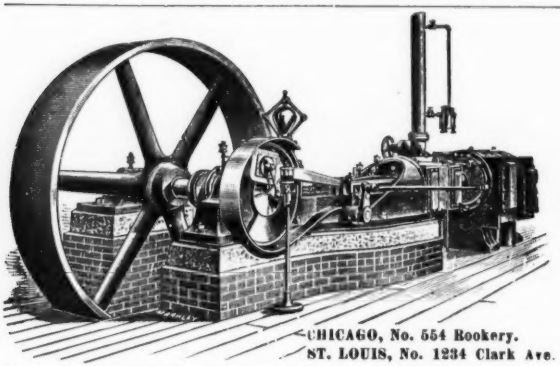

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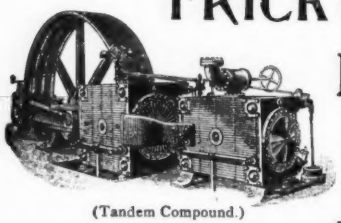

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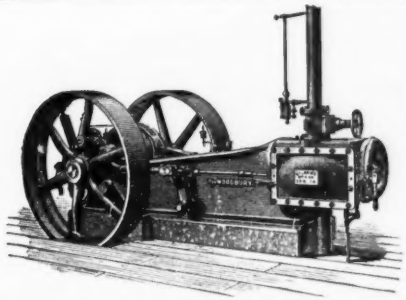

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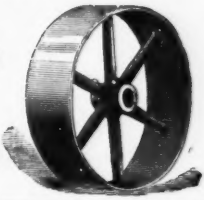

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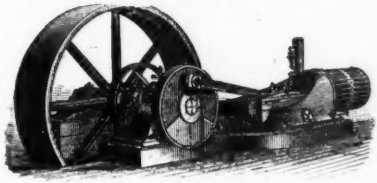

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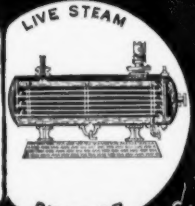

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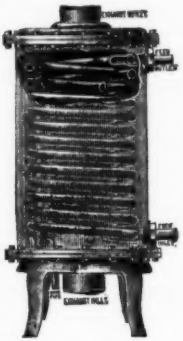

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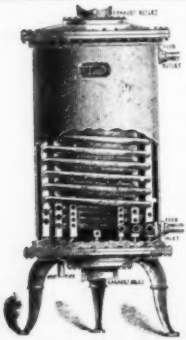

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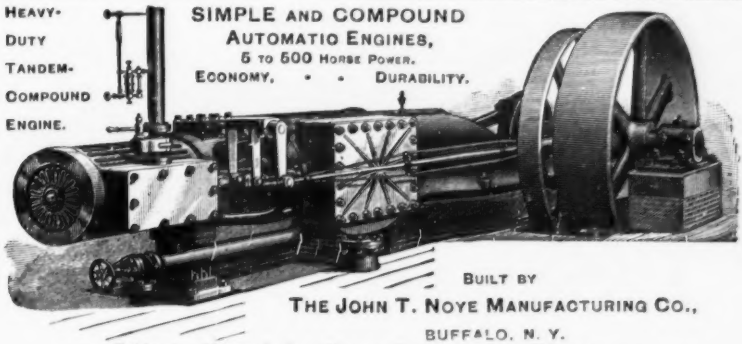

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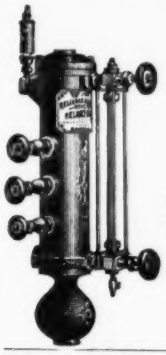

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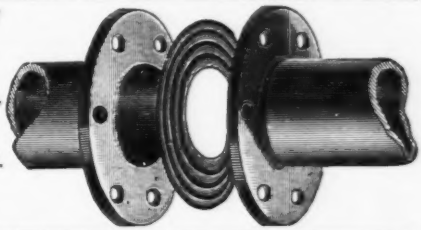

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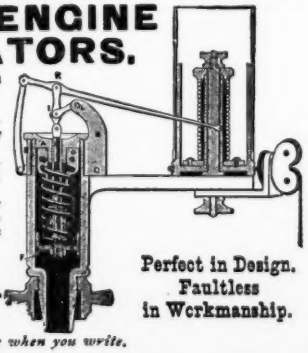

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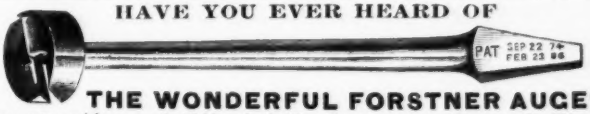

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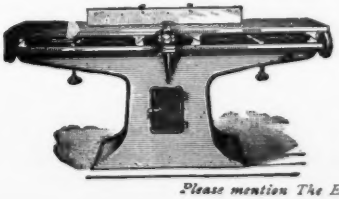

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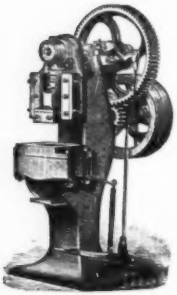

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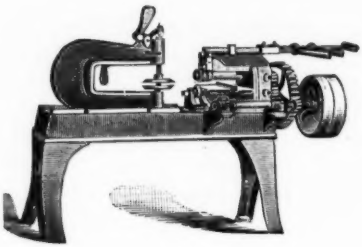

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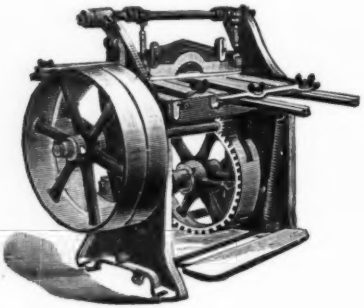

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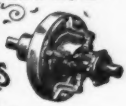
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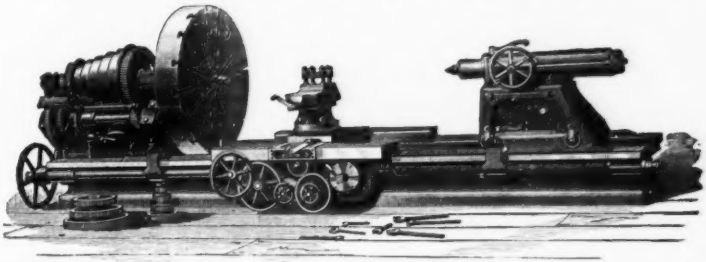

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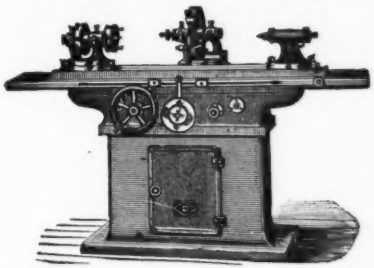

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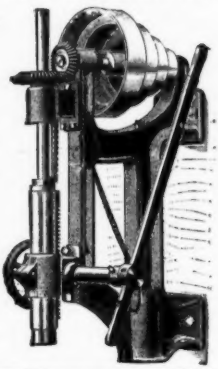

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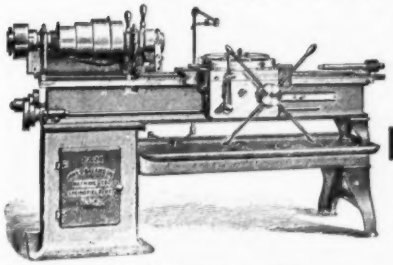

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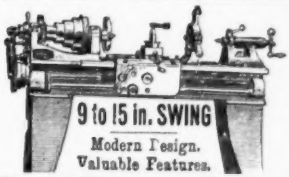

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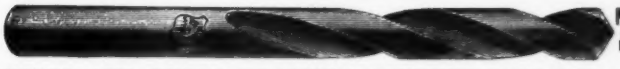

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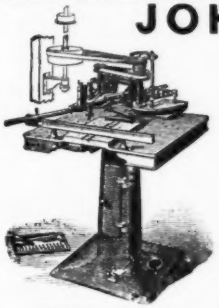

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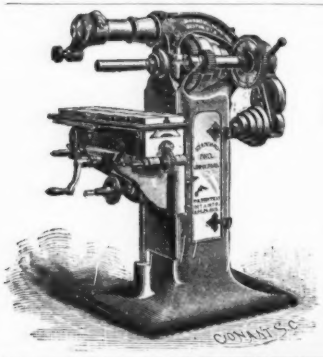

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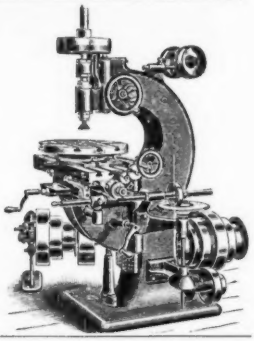

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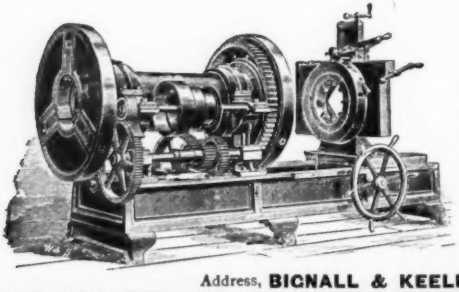

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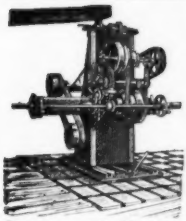

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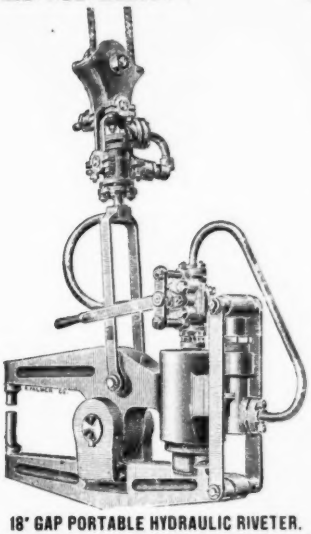

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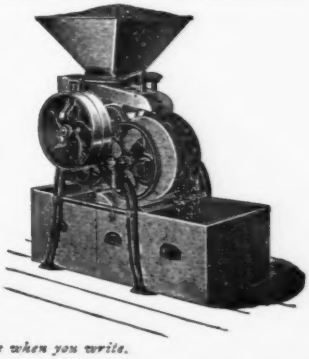

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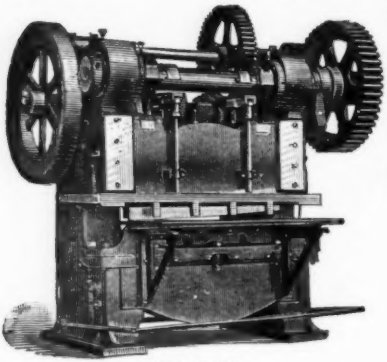

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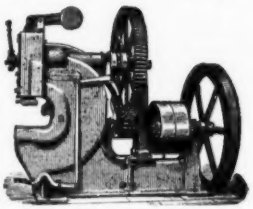

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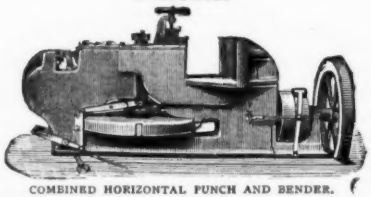

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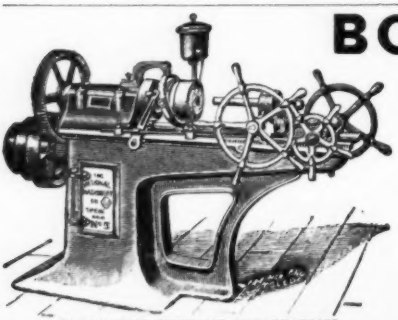

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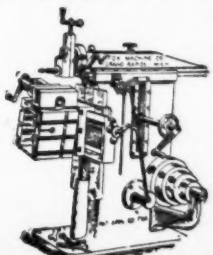

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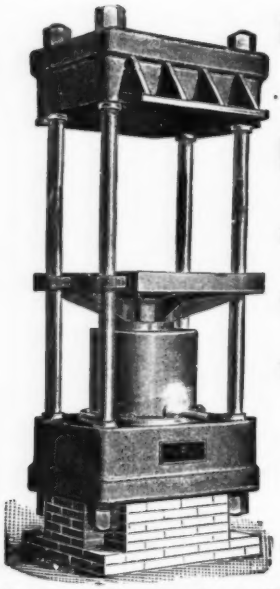

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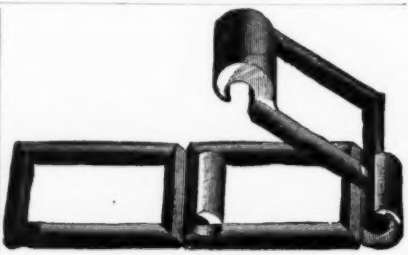

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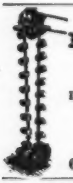

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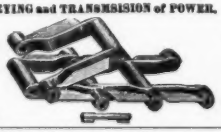

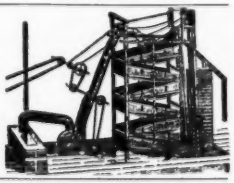

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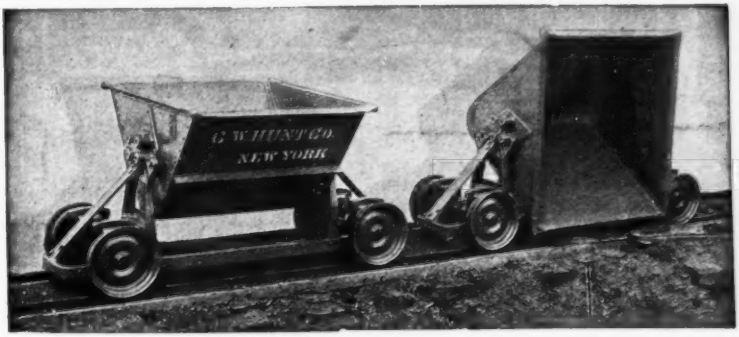

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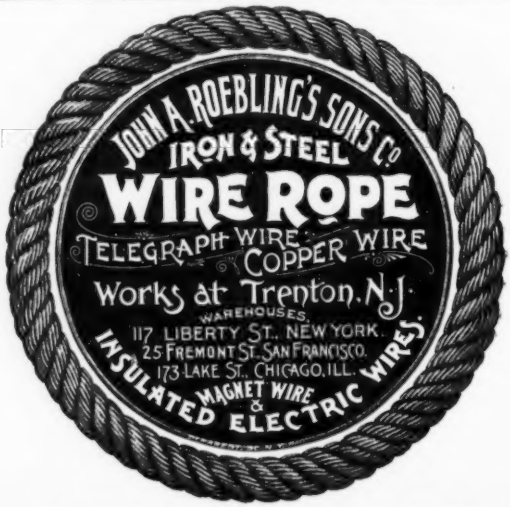

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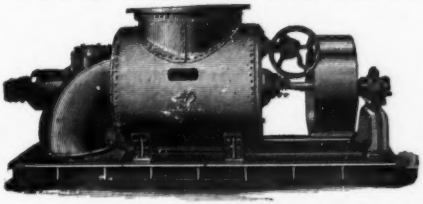

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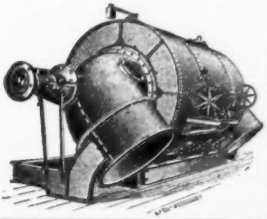

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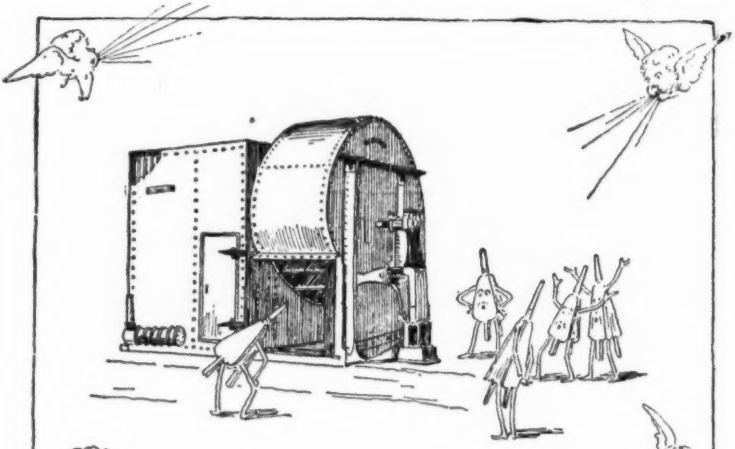

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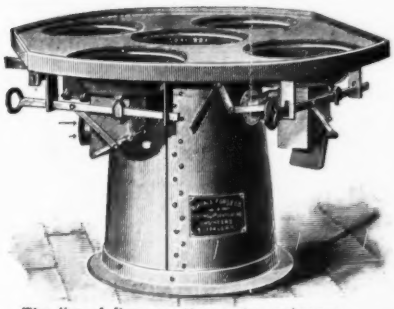

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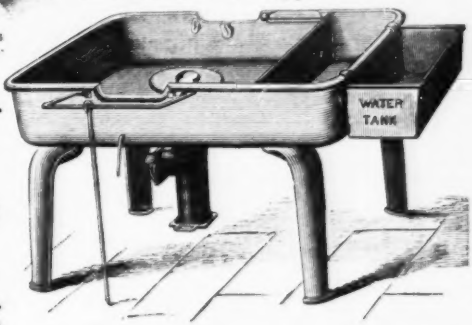

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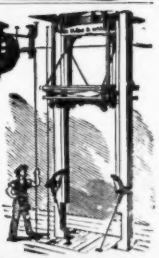

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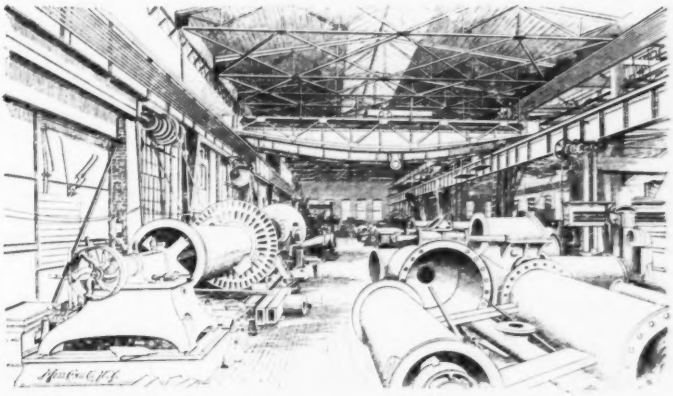

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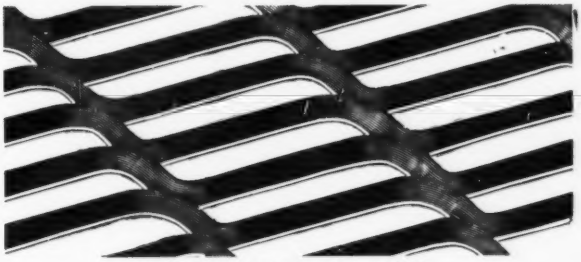

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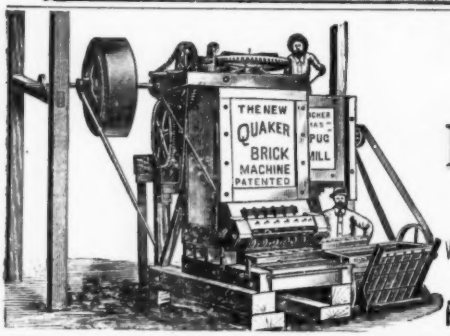

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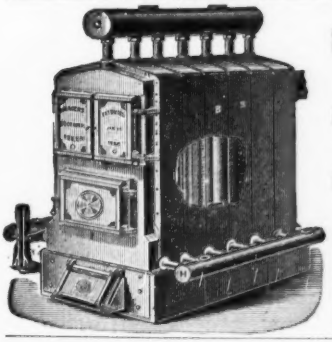

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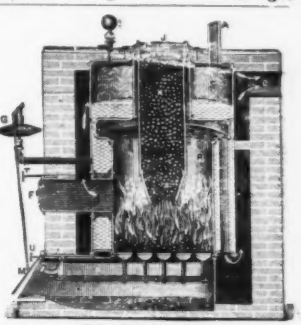

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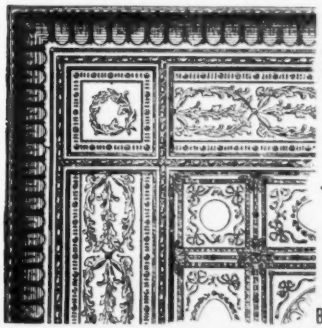

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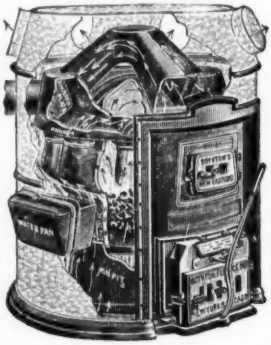

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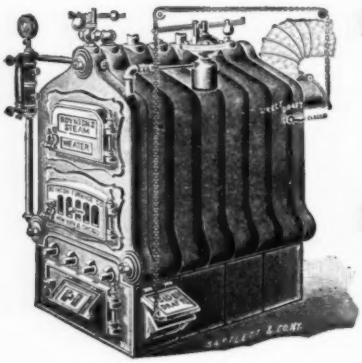

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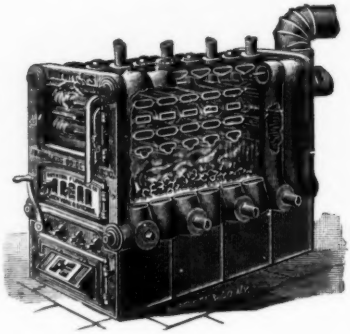

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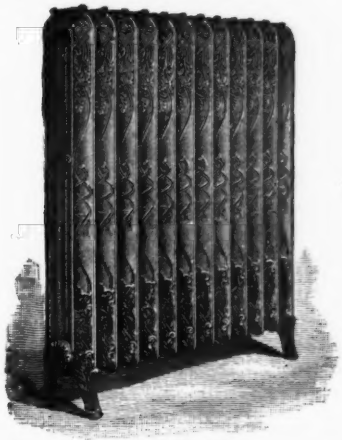

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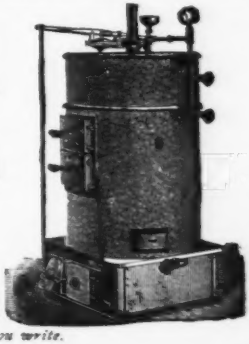

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